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MEMOIRS OF THE GEOLOGICAL SURVEY
OF THE
UNITED KINGDOM.

THE VERTEBRATA

OF THE
PLIOCENE DEPOSITS
OF
BRITAIN.

BY
E. T. NEWTON, F.G.S., F.Z.S.

PUBLISHED BY ORDER OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.



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P R E F A C E.

THE present Memoir, embracing an account of all the Vertebrate organisms at present known from the Pliocene Deposits of Britain, forms a companion volume to the Memoir on "The Vertebrata of the Forest Bed series of Norfolk and Suffolk," which was published in 1882. While recapitulating and bringing up to date the information we possess as to the species from the Forest Bed it treats more especially of the forms found in the Crag.

The total number of Vertebrata at present known from the Pliocene Deposits of the country amounts to 212. These have been catalogued and discussed by Mr. Newton in the present Memoir, which will, I trust, be of considerable service to those engaged in the study of the younger Tertiary formations. In connexion with this volume the reader should consult the Geological Survey Memoir, by Mr. Clement Reid, on "The Pliocene Deposits of Britain," published last year.

ARCH. GEIKIE,

Director-General.

31st March 1891.





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THE VERTEBRATA

OF THE

PLIOCENE DEPOSITS

OF

BRITAIN.

INTRODUCTION.

AN endeavour is made in the present Memoir to give some account of every species of Vertebrate animal which has been recorded from, or is now known to occur in, the Pliocene strata of Great Britain, and the work will form a companion volume to the "Vertebrata of the Forest Bed Series of Norfolk and Suffolk," which treats of the Vertebrate remains from that important section of the Pliocene deposits of East Anglia. In order to make the present volume complete in itself, all the species included in the "Forest Bed Memoir" are briefly alluded to, and such additional information as may have been obtained regarding them is here recorded. Besides this, several species, new to the "Forest Bed," have more recently been brought to light, and these also are included.

No illustrations of the Forest-bed Cervidæ were given in the earlier Memoir, but it has been decided to introduce several of them here, and they will be found on Plate IV., all the figures being one-fourth the natural size of the specimens.

For the execution of the lithographic plates illustrating this Memoir, I am under obligation to Mr. W. M. Redaway, who has spared no pains to make the drawings accurate, and, with few exceptions, they have been drawn directly from the specimens.

Fragmentary as are the vertebrate remains from the Forest-bed, those from the Crags are even more unsatisfactory for determination, being for the most part isolated teeth and pieces of bones, much rolled and water-worn. Nevertheless, some of these teeth are in a remarkable state of preservation, being very hard, of a reddish brown colour, and with a peculiar lustrous surface, which makes them elegant objects in the cabinet.

Allusion has been made in the previous Memoir to the various collections of Forest-bed Vertebrates, and they need not be again mentioned. Many of the Crag specimens described by earlier writers were derived from well-known Collections, which have since been dispersed, and among these may be especially noticed the Whincopp, Baker, Marshall, and Middleton Collections, the specimens from which are now, for the most part, preserved in other private cabinets or public museums, and in so far as I have been able to trace the more important fossils, their present resting place will be found recorded in the body of this work.

Among the larger series of Crag Vertebrata, attention may be directed to that in the Ipswich Museum, under the charge of Dr. J. E. Taylor, which, through the munificence of Sir Richard Wallace, now includes also the valuable collection brought together by the Rev. H. Canham, of Woodbridge, and that in the York Museum, under the charge of Mr. H. M. Platnauer, which is, for the most part, the generous gift of Dr. W. Reed of that city, who, as honorary curator, has charge of the Palaeontological Galleries. Next may be mentioned the collection in the British Museum under the supervision of Prof. W. H. Flower and Dr. Henry Woodward, which includes so many of the types described by the veteran palaeontologist Sir Richard Owen. In the Norwich Museum are some interesting specimens partly derived from the early collection made by Saml. Woodward, and partly contributed by Dr. Crowfoot and Mr. E. T. Dowson, as well as by the curator Mr. James Reeve, and each of these three gentlemen also possesses a private collection of Crag fossils. The Museum of Practical Geology has a good series of Pliocene Vertebrates, some of those from the Coralline Crag being especially noteworthy. Mr. Robert Fitch, of Norwich, possesses some fine specimens from the Norwich Crag of Thorpe, and Mr. E. Cavell, of Saxmundham, has a collection from the same horizon. Mr. J. J. Colman has added to his already valuable museum at Cliff House, Corton, Lowestoft, the large series of remains brought together by Mr. Randall Johnson from the Forest-bed, as well as some from the Norwich Crag of Horstead; among the latter the portions of elephant teeth may be especially noticed. Mr. E. C. Moor, of Great Bealings, has a number of specimens from the Red Crag, some of which are unique, and Mr. E. St. F. Moore, of Woodbridge, likewise has a series from the same horizon. The Rev. A. D. Philps, of Coggeshall, possesses the half of a fine example of *Choneziphius planirostris*, which, although dredged in the North Sea, is doubtless of Red Crag origin. Mr. Frank H. Harris, of Abingdon, and the Rev. J. Foster Lepine, of Croydon, also possess specimens which they have collected from the Suffolk Crag.

To all the gentlemen, whose names I have had occasion to mention, I desire to tender my heartiest thanks for the kindly assistance they have rendered in facilitating my examination of the fossils in their possession, or under their charge, and in many cases also my obligation is increased by the loan of valuable specimens, which have been freely placed at my disposal.

Little need be said regarding the sub-divisions of the Pliocene strata, as these are fully described by my colleague, Mr. Clement Reid, in his Survey Memoir on "The Pliocene Deposits of Britain," 1890, but attention may be directed to the fact that by far the larger part of the Vertebrate remains which are said to be from the Red Crag really come from the Nodule-bed (Bone-bed of some authors) which occurs at its base, and, further, that a Nodule-bed with similar fossils is known to occur also under the Coralline Crag. Many of the fossils from the Nodule-bed have been undoubtedly derived from the denudation of Eocene strata, while others seem to be the *remanié* of Pliocene beds older than the Coralline Crag, but of which no traces are known to occur in Britain. It has been suggested that most of Nodule-bed Vertebrates have been derived from Miocene strata, but there seems little evidence to support such an idea. Many Vertebrate remains have been found actually in the Coralline Crag and Red Crag above the Nodule-bed, and this fact will be duly noticed in the description of the species. The same is the case with the Norwich Crag, many specimens being obtained above the Basement Bed, or Mammaliferous Stone-bed.

The following table of British Pliocene deposits is taken from the Survey Memoir by Mr. Clement Reid, and will serve to indicate the horizons from which the fossils have been derived:—

NEWER PLIOCENE.	PLEISTOCENE.—Arctic Freshwater Bed (with <i>Salix polaris</i> , <i>Betula nana</i> , <i>Spermophilus</i> , &c.)		
	Leda-myalis Bed (classed provisionally with Pliocene).		
	Forest Bed Series.	Upper Fresh-water Estuarine Lower Fresh-water	Gravels with <i>Elephas meridionalis</i> at Dewlish, Dorset.
		Weybourn Crag (and Chillesford Clay ?)	
		Chillesford Crag.	
		Norwich Crag.	
		Red Crag, Butley, &c.	
		Walton Crag (Lower Red Crag).	
		St. Erth Beds.	
OLDER PLIOCENE.	Coralline Crag and Lenham beds.		
	Box Stones and phosphate beds at the base of the Red and Coralline Crags [Nodule-bed] (with <i>remanié</i> early Pliocene fossils).		

A list of Works on Pliocene Vertebrata, supplementary to that given in the Forest-bed Memoir, will be found on page 124, but for fuller Bibliographies relating to Pliocene geology, the reader is referred to Mr. Clement Reid's Survey Memoir above mentioned; also to Mr. H. B. Woodward's Memoir, The Geology of the Country around Norwich, 1881; and to that by Mr. W. Whitaker, The Geology of the Country around Ipswich, &c., 1885.

MAMMALIA

PRIMATES.

Remains of Primates have been found in Pliocene Beds in the South of France (Gervais, Palæont. Française, Edit. 2, p. 10, 1855) and in Italy (Forsyth Major, Quart. Journ. Geol. Soc., Vol. XLI., p. 1, 1885), and have been referred to the genera *Macacus* and *Semnopithecus*. No examples of this group, however, have been recorded from British Pliocene strata. The specimen to which Sir Richard Owen gave the name of *Macacus pliocenus* (Brit. Foss. Mamm., page xlvi., 1846) was obtained from the Pleistocene deposit of Grays, Essex, which at that time was called "Newer Pliocene," Brickearth.

CARNIVORA.

Genus FELIS, Linnæus.

Mr. J. Gunn, in his "Geology of Norfolk," printed in "White's Gazetteer" (p. 11, 1883 Edition), gives the "Wild Cat" among other species from the Norwich Crag, as being in "the late Mr. Middleton's collection," but I have been unable to get any clue to the specimen on which this determination was based, or to find any corroborative evidence for the occurrence of the species in the Norwich Crag, and, although it is quoted by Messrs. R. and A. Bell, on Mr. Gunn's authority (Proc. Geol. Assoc., Vol. II., p. 212, 1872), I do not feel justified in retaining it as a Crag species. Prof. E. Ray Lankester (Quart. Journ. Geol. Soc., Vol. XXVI., p. 511, 1870) alluded to two feline upper carnassial teeth, one in Mr. Canham's collection (now in the Museum at Ipswich) and the other in Mr. Baker's collection (now in the Reed collection, York Museum). Both these teeth are now referred to *Hyæna striata*, the one at Ipswich (Plate I., fig. 9) having been figured by Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 365, 1886).

Mr. R. Fitch, of Norwich, has a very much worn feline tooth (Plate I., fig. 2) from the Norwich Crag of Thorpe, which seems to be the specimen alluded to as *Felis pardoides* in Prof. Prest-

wich's list of mammals from this deposit (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871), but it is too large for *F. pardoides*, and is provisionally referred to *Machærodus*.

A portion of a remarkably flattened humerus from the Forest-bed of Kessingland, now preserved in the British Museum, and a portion of a fibula, also from the Forest-bed and now in the King collection in the Museum of Practical Geology, have been provisionally referred to the genus *Felis* (Mem. Geol. Surv., Vert. Forest Bed, 1882, p. 23); it is possible, however, that they may be parts of *Machærodus*.

FELIS PARDOIDES, OWEN.

PLATE I., FIG. 1, *a*, *b*.

A left lower sectorial tooth (m. 1) of a feline animal was found by Mr. Colchester in the Red Crag of Newbourn, near Woodbridge; and Sir R. Owen (Ann. Mag. Nat. Hist., Vol. IV., p. 186, 1840) found it to be "exactly similar in size and shape to the corresponding tooth of the Leopard." It was subsequently named *Felis pardoides* (Owen, Brit. Foss. Mamm., 1846, p. 169, fig. 66). The specimen (Plate I., fig. 1) is now in the Ipswich Museum.

Another tooth (which I have been unable to trace) from a Red Crag Pit, five miles from Newbourn, was afterwards described by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 226, fig. 19, 1856), and referred to the same species, he at the same time saying that "The *Felis antediluviana* of Kaup, from the Miocene sand of Eppelsheim, and the *Felis pardinensis* of Croizet and Jobert, from the Miocene strata of Auvergne, correspond in size with the *Felis pardoides* of the Red Crag of Suffolk." Dr. Falconer (Palæont. Mem., 1869, Vol. II., p. 59) recognised the similarity between the British and Auvergne specimens, and said, "it remains to be shown that the former is specifically different from the latter form."

The tooth of *Felis pardus*, figured by Dawkins and Sanford (Brit. Pleist. Mamm. Pal. Soc. for 1871, p. 177, Plate xxiv., fig. 2), from Bleadon Cave, is rather larger than the Crag specimen; but it seems very probable that they represent but one species, and will eventually, together with the Eppelsheim and Auvergne specimens, be referred to the living species, *F. pardus*.

Genus MACHÆRODUS, Kaup.

PLATE I., FIG. 2, *a*, *b*.

The occurrence of this genus in the "Forest Bed" of Norfolk was first made known by Prof. Lankester (Geol. Mag., Vol. VI., p. 440, 1869). The form of the single canine, which was the only specimen then known from this horizon, seemed to resemble more the tooth of *M. cultridens*, from the Val d'Arno, than the

broader form from British caves, which Sir R. Owen had called *M. latidens*. The same opinion was expressed in the Geological Survey Memoir (Vertebrata of the Forest Bed, p. 21, 1882), and more recently Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 309, 1886), when considering the affinities of a lower jaw of this genus, which had been found in the Forest-bed of Kessingland, and described by Mr. J. Backhouse (Ibid., p. 309), came practically to the same conclusion, namely, that the Forest-bed form of *Machærodus* seemed to be the *M. cultridens*; but that the evidence was not sufficient to justify a reference of the specimens to that species.

If, as Dr. E. Fabrini states (Boll. Com. Geol. Ital. Ser. 3, Vol. I., p. 161, 1890), the canines of *M. cultidens* have no crenations, then the Forest-bed *Machærodus* cannot belong to that species; but I am not satisfied that we should be correct in following Dr. Fabrini in referring the Forest-bed specimens to *M. crenatidens*, for it seems to me far from certain that *M. crenatidens* is specifically distinct from Owen's *M. latidens*.

Mr. R. Fitch has a portion of a large carnassial tooth from the Norwich Crag of Thorpe, very much worn by the opposing teeth; this may be the tooth which has been thought to be *Felis pardoides* (Prestwich, Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871), but it is far too large for that species. The manner in which this tooth is worn makes it look like a tooth of *Hyæna*, but its shape is quite different from any tooth of that animal. The teeth of *Machærodus* are sometimes similarly worn away, and as this tooth agrees in size with *Machærodus*, it is provisionally referred to that genus. The tooth of the closely allied genus *Eusmilus* figured by Mr. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part v., p. 311, 1887) may be compared with this.

The genus *Machærodus* occurs in Miocene beds at Eppelsheim. In the Pliocene of Pikermi, Mont Léberon, Mont Perrier, the Val d'Arno, and in India; possibly also in the Norwich Crag of Britain. It is also met with in the Norfolk Forest-bed, as well as in Pleistocene beds of Britain and on the Continent.

Genus HYÆNA, Zimmermann.

HYÆNA CROCUTA, ERXLEBEN.

(*Spotted Hyæna*.)

PLATE I., FIG. 8, a, b.

The remains of a large form of *Hyæna*, similar to those which are now generally looked upon as a spelæon variety of *H. crocuta*, have been obtained from the Forest-bed of Corton and Kessingland, near Lowestoft (Geol. Mag. Dec., 2, Vol. X., p. 433, 1883, and Quart. Journ. Geol. Soc., Vol. XXXIX, p. 580, 1883), they are in the possession of Mr. J. J. Colman at Corton,

Mr. Angel at Beccles, and in the Backhouse Collection at York. Mr. A. Savin also has specimens from the same horizon near Cromer.

Hyæna crocuta has also been met with in the Caves and Pleistocene deposits of Britain and many localities in Europe. At the present day it is living in Africa, south of the Sahara.

HYÆNA STRIATA, ZIMMERMANN.

= *H. ANTIQUA, LANKESTER.*

(*Striped Hyæna.*)

PLATE I., FIGS. 9, a, b, 10, a, b.

Prof. Lankester (Ann. Mag. Nat. Hist., Series 3, Vol. XIII., p. 56, Plate viii., Vol. XIV., p. 358, Plate viii., 1864) described two premolars of *Hyæna* from the Red Crag of Felixstow, Suffolk, which he believed represented a new species, and named it *Hyæna antiqua*. One of these (upper p.m. 3) is now in the British Museum (No. 37,983). These teeth were compared with the recent forms, but were scarcely sufficient to permit of definite specific determination, and indeed their close relationship to *H. striata* was acknowledged. Prof. Lankester afterwards (Quart. Journ. Geol. Soc., Vol. XXVI., p. 511, Plate xxiii., Figs. 5, 6, 1870) noticed another *Hyæna* tooth (Plate I., Fig. 10) from the Red Crag of Woodbridge (then in the Baker Collection and now in York Museum), which he also referred to *H. antiqua*.

Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 364, 1886, and Cat. Foss. Mamm. British Mus., Part v., p. 315, 1887) has more recently figured a right upper carnassial (p.m. 4) from the Red Crag of Trimley St. Mary (Plate I., Fig. 9), preserved in the Ipswich Museum, which is precisely like the same tooth of *Hyæna striata*, and differs from that of *H. crocuta* in the relatively smaller size of the hinder flattened cusp; and there can be little doubt as to his being justified in referring it to *H. striata*. There is another upper carnassial of the left side in the Reed Collection, York Museum, from the Red Crag of Woodbridge, presenting precisely the same characters, but more worn. These two carnassial teeth have been alluded to as "feline" (Quart. Journ. Geol. Soc., Vol. XXVI., p. 511). The improbability of the specimens described by Prof. Lankester belonging to a second species, seeing that they agree so closely with *H. striata*, has led Mr. R. Lydekker to include them all under the latter; which species he has also identified in the Pliocene of the Val d'Arno (Cat. Foss. Mam. Brit. Mus., Part i., p. 88, 1885, and Quart. Journ. Geol. Soc., Vol. XLIV., p. 62, 1890). A right lower canine tooth (Plate I., Fig. 11) from the Red Crag of Felixstow, in the Reed Collection, York Museum, may perhaps be referred to this species; but it

has a very close resemblance to a tooth which has been figured as *Hyænarctos minutus* (Koken, Sitzb. Gesell. Naturf. Freunde, Berlin, Nr. 3, 1888, p. 47). Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871) included *H. antiqua* among the Mammals from the Norwich Crag at Thorpe, said to be in the collection of Mr. R. Fitch of Norwich, and this has been copied by other writers; but unfortunately, a careful search through Mr. Fitch's collection has failed to reveal any specimen which can be called *Hyæna*. It is just possible that the much-worn tooth, which I have thought might be *Machaerodus* (Plate I., Fig. 2), may be the specimen alluded to; but after a careful comparison with *Hyæna*, I am convinced that it cannot be referred to the latter genus.

Adopting Mr. Lydekker's determination of the specimens, *Hyæna striata* is represented in the Red Crag Nodule-bed by several specimens from various localities in Suffolk, and it has also been recognised in the Pliocene of the Val d'Arno in Italy. At the present day *H. striata* is living throughout the Indian peninsula, and extends through South-western Asia to Northern Africa.

Genus CANIS, Linnæus.

The occurrence of this genus in the British Pliocene was first noticed by Sir R. Owen in 1856 (Quart. Journ. Geol. Soc., Vol. XII., p. 227). Prof. Lankester, in 1864 (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV., p. 358, Plate viii.), described and figured a slender tooth from the Red Crag as *Canis primigenius* (Plate I., fig. 6); but it is doubtful whether this generic reference is correct (see p. 9).

CANIS LUPUS, LINNAEUS.

(*Wolf.*)

PLATE I., FIGS. 3, a, b, 4, a, b.

A left upper carnassial tooth from the Red Crag, near Woodbridge, was figured and referred to this species by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 227, fig. 21, 1856), who also identified a humerus from the Norfolk Forest-bed in the King Collection now in the Museum of Practical Geology (Mem. Geol. Surv., Vert. Forest Bed, p. 19, Plate iv. fig. 1, 1882).

The occurrence of this species in the Forest-bed has been corroborated by the subsequent finding of several specimens in beds of the same age at Kessingland, Overstrand, and Runton.

In the Reed Collection, York Museum, there is a left upper premolar (Plate I., fig. 4), labelled Red Crag, which was originally in the collection of Col. Alexander, and two canine teeth from the

Red Crag of Boyton, all of which agree in form with the corresponding teeth of the wolf.

Canis lupus has thus been recognised in the Red Crag Nodule-bed of Suffolk, in the Forest-bed of Norfolk and Suffolk, in Pleistocene deposits throughout Europe, and is now living throughout the northern parts of the Northern hemisphere.

CANIS VULPES, LINNÆUS.

(*Fox.*)

PLATE I., FIG. 5.

A portion of a skull with teeth, obtained by the late Mr. R. Bell from the Red Crag above the Nodule-bed at Boyton, Suffolk, was recognised as *Fox* by Mr. W. Davies of the British Museum, and afterwards described by Mr. R. Lydekker (Geol. Mag., Dec. 3, Vol. I, p. 443, 1884, and Cat. Foss. Mamm. Brit. Mus., Part i., p. 131, 1885).

This specimen seems to be rather larger than the skulls of recent Foxes with which it has been compared; but there is no question as to its specific identity.

There has been some doubt expressed as to the true age of this fossil, for it seemed possible that it might have been part of a recent fox buried in a deep burrow; but Mr. R. Bell, whose opinion in such matters carried great weight, was satisfied that the skull was truly of Red Crag age.

Canis vulpes has thus been recorded from the true Red Crag of Suffolk, with some doubt from the Norfolk Forest-bed (Mem. Geol. Surv., Vert. Forest Bed, p. 19, Plate iv., fig. 2, 1882), and it is commonly found in Cave-deposits throughout Europe; a geographical distribution which it at present maintains.

CANIS (?) PRIMIGENIUS, LANKESTER.

PLATE I., FIG. 6.

This species was founded by Prof. Lankester (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV., p. 358, Plate viii., fig. 11, 1864), for a single, slender, much denuded tooth from the Red Crag (Nodule-bed) of Woodbridge, in the Whincopp collection, now in the Reed collection, York Museum. Some rolled specimens, apparently belonging to the same form, are in the Ipswich Museum; but nothing has been found to extend our knowledge of this species.

Prof. W. Boyd Dawkins called my attention to the coarse wrinkling of what appears to be a portion of the enamel preserved in the type specimen, which is quite unlike that of any known

species of *Canis*; and, indeed, the shape of the tooth would be remarkable in this genus. It seems highly probable that this tooth will prove to be Cetacean; but as I know of nothing exactly of the same form, it is for the present left with doubt in the genus *Canis*.

Genus PTERODON? Blainville.

PLATE I., FIG. 7, *a, b.*

Prof. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 227, Fig. 20, 1856) figured and described a tooth from the Red Crag of Suffolk which he thought was allied to *Hyænodon* and *Pterodon*. He says concerning this sectorial tooth that it "deviates from the feline type and approaches that of the carnassial in the Glutton, *Hyæna*, and *Grison*, but with a minor development of the outer cingulum it closely resembles one of the teeth of the Miocene carnivora to which the generic names *Hyænodon* and *Pterodon* have been given."

I have been unable to trace the specimen here referred to, but provisionally retain the genus on Sir R. Owen's authority. The tooth was most probably obtained from the Nodule-bed of the Red Crag.

Genus MUSTELA, Linnæus.

MUSTELA MARTES, LINNÆUS.

(=MARTES SYLVATICA, NILSSON.)

(*Pine Marten.*)

(Vert. Forest Bed, p. 25. PLATE IV., FIG. 3, 3a.)

The occurrence of the Marten in the Forest-bed at West Runton was first noticed in 1880 (Geol. Mag., Dec. 2, Vol. VII., p. 150); the specimen was figured in the Survey Memoir under the name *Martes sylvatica*; but I am not aware that it has been recorded from any other Pliocene deposit. The Marten is, however, known to occur in Cave-deposits (Vide Boyd Dawkins, Quart. Journ. Geol. Soc., Vol. XXV., p. 192, 1869, and Vol. XXXVI., p. 400, 1880).

With regard to the name which should be adopted for this species; if the two genera *Mustela* and *Martes* are distinct then the present form must be called *Martes sylvatica*, as was done by Mr. Edw. R. Alston (Proc. Zool. Soc., 1879, p. 468); but when they are united in a single genus, then the species under consideration is rightly called *Mustela martes*; and as the latter course is adopted by Professor Flower (Cat. Vert. Coll. Surgeons,

Part ii., 1884) and by Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part i., p. 176, 1885), it is also followed here.

Mustela martes is found, at the present day, distributed over a large part of Europe and Asia, and according to Mr. E. R. Alston it is the only Marten known to occur in the British Isles.

MUSTELA PUTORIUS ? LINNÆUS.

(*Pole-cat.*)

There is in the British Museum a fragment of a right mandible, from the Coralline Crag of Orford, which Mr. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part i., page 179, 1885) identifies as belonging to this species; but there seems to be considerable doubt as to its true age, for he says: "There does not appear to be any evidence to show whether this specimen is a true Crag fossil, or whether it has been introduced into that deposit." It would be unwise therefore to accept this species definitely as a Crag form until we have corroborative evidence. *M. putorius* is known from Cave-deposits, but I am not aware of any other record of its having been found in the *Pliocene*.

The Polecat is now living throughout the northern parts of Europe.

Genus GULO, Storr.

GULO LUSCUS, LINNÆUS.

(*Glutton.*)

(Vert. Forest Bed, p. 17. PLATE VI., FIG. 1, 1a.)

The presence of the Glutton in the Forest-bed was made known in 1880 (Quart. Journ. Geol. Soc., Vol. XXXVI., Proceedings, p. 99, and Geol. Mag. Dec. 2, Vol. VII., p. 424, Plate xv.), by the finding of a portion of a jaw at Mundesley. The specimen is in the collection of Mr. R. Fitch, at Norwich.

The Glutton also occurs in British and European Cave deposits, and at the present day is living throughout the northern parts of Europe, Asia, and America.

Genus LUTRA, Erxleben.

LUTRA VULGARIS, ERXLEBEN.

(*Otter.*)

PLATE I., FIG. 16 a, b.

The occurrence of the common Otter in the Norwich Crag has been noted by Sir R. Owen (Brit. Foss. Mamm., p. 121, 1846),

who says: "A portion of the lower jaw of an Otter, from the Norwich Crag of Southwold, and the characteristically bent humerus from the same formation near Aldborough carry the date of the *Lutra vulgaris* in England as far back as the older Pliocene period." Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871) also includes the genus *Lutra* in his list of mammals from Thorpe pit, in Mr. Fitch's collection. I have been unable to find either of these specimens in any of the collections I have been able to examine. Mr. Fitch has no knowledge of them, and a close search through his collection failed to reveal anything which could be referred to *Lutra*. I am unable, therefore, to verify this species as belonging to the Norwich Crag Fauna.

A lower jaw (Plate I., Fig. 10), undoubtedly belonging to *L. vulgaris* (Geol. Mag., Dec. 3, Vol. IV., p. 145, 1887), has been found by Mr. A. Savin, of Cromer, in the Forest-bed at East Runton; and the Pliocene age of the species is thus assured.

The common Otter (*L. vulgaris*) has not been recognised in Pliocene strata on the continent, unless indeed the *L. affinis* should prove to be identical with it; the genus, however, has been met with at several localities. *L. vulgaris* has been found in Britain, possibly in the Norwich Crag, certainly in the Forest-bed, in Pleistocene and in Peat-deposits; and it is now living in this country, throughout Europe, and in Asia.

LUTRA DUBIA, BLAINVILLE.

PLATE I., FIG. 15, a, b, c.

The above species was established by M. De Blainville (Ostéographie, Genus *Mustela*, p. 76, Plate xiv., 1848 ?) for the lower jaw of an Otter from the Miocene of Sansan. Mr. E. C. Moor, of Great Bealings, Suffolk, possesses a lower jaw from the Red Crag Nodule-bed of Foxhall, 4 m. S.W. of Woodbridge, which has been referred to the same species (Quart. Journ. Geol. Soc., Vol. XLVI, p. 444. 1890). This specimen differs from the lower jaw of the recent *Lutra vulgaris* in having the carnassial tooth proportionally longer and narrower; also the hinder fangs of all the premolars are much larger than the front ones, this being especially the case with the tooth immediately in front of the carnassial. These characters are precisely those found in the *Lutra dubia*, to which species, therefore, the Crag fossil is referred, although the Sansan specimen has the carnassial tooth a little wider and not quite so much curved.

The type specimen of *L. dubia* was obtained from the Miocene of Sansan; the species is now recognised in the Nodule-bed of the Red Crag. The specimen in the British Museum (No. 27,486),

from Eppelsheim, was referred to *L. dubia* (Cat. Foss. Mamm., Part i., p. 191, 1885) has since been described by Mr. Lydekker (Proc. Zool. Soc., 1890, p. 3) as a new species, *L. hessica*.

LUTRA REEVEI, NEWTON.

PLATE I., FIG. 13, *a*, *b*, *c*.

Mr. James Reeve, the Curator of the Norwich Museum, has obtained from the Norwich Crag of Bramerton a remarkable carnivore tooth which is so unlike any form previously known that it has been described (Quart. Journ. Geol. Soc., Vol. XLVI., p. 446, 1890) as a new species, and, from its general resemblance to some of the more aberrant forms of Otter, has been placed in the genus *Lutra*.

The specimen is an unworn germ of a carnassial tooth; the front part is pointed and bears three low cusps of equal size, while the hinder part is truncated, with a depressed upper surface bounded on the outer side by a cusp, a little smaller than the three anterior cusps, and on the inner side by a ridge. Although the tooth is so unlike the lower carnassial of the common Otter, yet this low crowned type of tooth is found in the Indian clawless Otter, *Lutra cinerea*, and the three equal anterior cusps are paralleled in the fossil species lately described by Mr. Lydekker (Proc. Zool. Soc., 1890, p. 3) as *Lutra hessica*.

Genus AILURUS, Cuvier.

AILURUS ANGLICUS, DAWKINS.

PLATE I., FIGS. 17, *a*, *b*, and 18, *a*, *b*.

A portion of a lower jaw with a carnassial tooth in place from the Red Crag Nodule-bed of Felixstow, which is preserved in the Reed Collection, York Museum, has been described by Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XLIV., p. 228, 1888) as a new species of the remarkable racoon-like Himalayan genus *Ailurus*, and named *A. anglicus*. This species was about one third larger than the living *A. fulgens*.

Another portion of a lower jaw, but without teeth, from the Red Crag Nodule-bed near Woodbridge, is preserved in the same collection, and is now also referred to *A. anglicus*. More recently (Quart. Journ. Geol. Soc., Vol. XLVI., p. 451, 1890) an upper molar tooth (Pl. I., fig. 18) has been found at the same horizon near Butley, which, while agreeing with the first upper true molar of *Ailurus fulgens* (Pl. I., fig. 19) in all the details of its structure, every cusp and each tubercle (with one exception) finding its counterpart in the recent form, is proportionally longer from before backwards and about one third

larger. There can be no question therefore as to the close affinity of this Crag form with the genus *Ailurus*, or as to the propriety of including this upper molar in Prof. Dawkins' species *A. anglicus*.

It is remarkable that the genus *Ailurus*, which is now restricted in range to the higher regions of the north-eastern Himalaya, and is, according to Dr. W. T. Blanford (Fauna of British India, Mammalia, p. 189, 1888) closely related to the American racoons, should be found fossil in the English Pliocene.

Genus HYÆNARCTOS, Falconer and Cautley.

PLATE I., FIGS. 20, *a*, *b*, 21, *a*, *b*, 22.

A right upper first true molar from the Red Crag near Waldringfield, in the Canham collection, and now in the Ipswich Museum, was described and figured by Prof. Flower in 1877 (Quart. Journ. Geol. Soc., Vol. XXXIII., p. 534), and as no appreciable difference could be detected between this and the corresponding tooth of *Hyænarctos sivalensis*, Falc. and Caut. it was provisionally referred to that species. Another upper first molar tooth (Plate I., fig. 20), but from the left side and unworn, was obtained by Mr. Charlesworth from the Red Crag of Felixstow, and is now in the Reed Collection in the York Museum. This specimen was recognised as belonging to *Hyænarctos* by Mr. W. Davies of the British Museum, and was noticed by Prof. Flower in the paper above referred to. Mr. R. Lydekker (Pal. Ind., Ser. 10., Vol. II., p. 227; and Cat. Foss. Mamm. Brit. Mus., Part i., p. 155, 1885) is of opinion that these Red Crag teeth ought not to be referred to the species *H. sivalensis*; and thinks it better for the present simply to retain them in the genus *Hyænarctos* without giving them a specific name; a suggestion which is here accepted.

There is in the Reed Collection, York Museum, a lower right second molar tooth (Plate I., fig. 21), from the Red Crag of Felixstow, which agrees so closely with the corresponding tooth of *Hyænarctos* as to leave no doubt that it belongs to that genus. The crown measures 29.5 mm. in length, 22 mm. in width, and 13 mm. in height. The inner and outer surfaces are so much inclined as to make the area of the summit of the crown narrower than in the species figured by Mr. Lydekker from India (Pal. Ind., Ser. 10. Vol. II. Plate xxxi.), or that from China (Cat. Foss. Mamm. Brit. Mus., Part i., p. 157). There is a strongly developed cingulum on the outer side which rises anteriorly and posteriorly almost to the top of the terminal cusps. The front of the tooth is higher than the back, and the upper surface has the tubercles and wrinkles only slightly developed.

Mr. Reed's Crag collection includes the crown of a large lower right canine (Plate I., fig. 22), also from the Red Crag of Felixstow, which has on the inner side a prominent ridge, and is

unlike the canine tooth of either *Felis* or *Ursus*. This tooth is referred to the present genus.

Hyænarctos is represented by different specific forms, in the Pliocene of the Siwaliks, from whence the original specimens were obtained; in the Pliocene marine sands of Montpellier (Gervais, Pal. Gen., p. 209), also in Miocene beds at Sansan, Gers, and Alcoy in Spain (Gervais, p. 210). A single tooth in the British Museum from beds, probably of Pliocene age, in the South of China, has been referred to this genus by Mr. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part i., p. 156, 1885).

A small species of *Hyænarctos* from the Miocene of Kieferstädtl, Upper Silesia, has been described by Herr Koken (Sitzb. Ges. Naturf. Freunde, Berlin, No. 3, p. 44, 1888).

In Britain this genus is only known from the Red Crag Nodule-bed.

Genus URSUS, Linnæus.

Sir Richard Owen seems to have been the first to notice the occurrence of the genus *Ursus* in the Suffolk Crag (Brit. Foss. Mamm., p. 105, 1846, and Quart. Journ. Geol. Soc., Vol. XII., p. 227, 1856). He says: "The ursine genus is represented by an ante-penultimate grinder of the right side, upper jaw, of a Bear, somewhat smaller than the corresponding tooth of *Ursus spelæus*. The fossil in question was obtained by Mr. Colchester from the Red Crag of Newbourn, near Woodbridge, Suffolk. The specimen is now in the collection of the Rev. Edward Moore, of Bealings, near Woodbridge."

Unfortunately, I have been unable to verify this determination. Mr. E. C. Moor, of Great Bealings (son of the late Rev. Edward Moor), has still in his collection a tooth (Plate III., fig. 15) said to be the one alluded to in the above quotation; but this has less resemblance to *Ursus* than it has to *Sus*, and possibly it may be *Sus palæochærus*.

In 1864 Prof. Lankester described a slender canine tooth (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV., p. 358, Plate viii., figs. 1 and 4) from the Red Crag of Newbourn, in Mr. Whincopp's collection, now in the Reed Collection, York Museum, which he referred with little doubt to *Ursus arvernensis*, and still maintained this determination in 1870 (Quart. Journ. Geol. Soc., Vol. XXVI., p. 511). This tooth (Plate viii., fig. 16) does not seem to me to agree with the canine of *U. arvernensis*, and the roughness of the enamel is quite unlike that of ursine teeth, a fact which led Prof. Boyd Dawkins to doubt its belonging to this genus, and indeed it seems much more probable that it will prove to be an anterior tooth of *Squalodon*, and cannot therefore be taken as evidence of the occurrence of *Ursus* in the Red Crag.

Mr. Prestwich quotes *Ursus* (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871) as being in Mr. Fitch's collection from

the Norwich Crag of Thorpe, and it has been given by other writers on this authority; but a careful search through Mr. Fitch's collection of Norwich Crag fossils has failed to bring to light any specimen which could be taken as representing the genus *Ursus*.

So far as I have been able to ascertain, all other notices of the genus *Ursus* occurring in the Crag rest upon the authorities above noticed.

URSUS ARVERNENSIS ? CROIZET & JOBERT.

PLATE I., FIG. 12, *a, b.*

There is in the Reed collection, York Museum, a molar tooth from the Red Crag Nodule-bed of Woodbridge, which Prof. Boyd Dawkins thought might belong to *Ursus arvernensis*. This is a left lower second molar, and is smaller than the corresponding tooth of *U. arvernensis* with which I have been able to compare it, but agrees very closely in form. The upper surface is unworn, and the tubercles and wrinkles are not strongly marked. The length of the crown is 20 mm., the width 12 mm., and the height 6 mm. The fangs are much broken. This specimen, so far as I am aware, is the only one which can be taken as possible evidence for the occurrence of *U. arvernensis* in the English Crags, or indeed in England, and this does not seem to me to be altogether free from doubt. The tooth referred to *U. arvernensis* by Prof. Lankester is not now regarded as such (see p. 15), and no specimens are known from the Cromer Forest-bed (see Vert. Forest Bed, pp. 9 and 16, 1882).

In France this species occurs in the Auvergne Pliocenes; and it may be that the *U. minutus* from Montpellier (Gerv., Pal. Franc., Edit. 2, p. 206, Plate viii., fig. 1), may belong to the same species. Gervais (Pal. General, p. 150, 1867-69) seemed to think that his specimen might belong to *Hyænarcos*, and certainly our specimen from the Red Crag is not very unlike the teeth figured by Koken (Sitzb. Ges. Naturf. Freunde, Berlin, Nr. 3, 1888, p. 45) as *Hyænarcos minutus*.

URSUS HORRIBILIS ? ORD.

(= URSUS FEROX-FOSSILIS, BUSK.)

(*Grizzly Bear.*)

(Vert. Forest Bed, p. 12, No. 10. PLATE I., FIG. 5, 5a.)

One specimen, a maxilla with two teeth, from the Forest-bed of Mundesley, has been doubtfully referred to this form; but otherwise the species has not been recognised in any Pliocene

deposit; it has, however, been met with in British and European Cave-earth and other Pleistocene beds. The species is now living in North America.

URSUS SPELÆUS, ROSENmüLLER.

(*Cave Bear.*)

(Vert. Forest Bed, p. 5. PLATE I., FIGS. 1-14.)

The remains of *Ursus spelæus* are not uncommon in the different divisions of the Forest-bed Series in Norfolk and Suffolk, as well as in British and European Caves, but it has not been met with in any Crag deposit.

CARNIVORE TOOTH OF DOUBTFUL AFFINITIES.

PLATE I., FIG. 14, *a, b.*

I am indebted to the Committee of the Wisbeach Museum for the opportunity of examining a peculiar carnivore tooth, there preserved, which is labelled Crag, Kessingland. This tooth resembles the left upper molar of a Wolf or Dog, but a close comparison shows important differences between them. The posterior outer cusp is larger than the anterior, and there are only two inner cusps instead of three; also the smooth space in the middle of the tooth is larger than in the Wolf or any species of *Canis* I have been able to examine. The presence of *Ailurus* in the Crag led me to make comparison with that form, but the differences are even greater than those above noticed. Perhaps the tooth which comes nearest to this specimen is the first molar of the Miocene *Cephalogale Geoffroyi*, figured by Mr. H. Filhol in his *Mammifère fossiles de L'Allier* (Ann. Sci. Géol., Vol. X., Plate 17, 1879). After a long search I am unable to find anything exactly agreeing with this tooth; but it is figured in the hope that this may lead to its identification.

Genus TRICHECHUS, Linnæus.

TRICHECHUS HUXLEYI, LANKESTER.

PLATE II., FIG. 3.

(Also Vert. Forest Bed, Plate V., fig. 3.)

Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXI., p. 226, 1865) described, under the generic name of *Trichecodon*, several portions of large tusks from the Red Crag of Suffolk, which were

evidently nearly allied to the living Walrus, and called them specifically after Prof. Huxley. Subsequently (*ibid.*, Vol. XXVI., p. 511, 1876) he called attention to a portion of a tusk from the Belgian Pliocene, which Prof. Van Beneden had shown him in 1864, and to the descriptions by the Vicomte Du Bus (Bull. Ac. Roy. Belg., Vol. XXIV., p. 566, 1867) of *Alachtherium Cretsi*. The tusk he thought agreed in form with the Suffolk specimens. Again, in 1882 Prof. Lankester (Trans. Linn. Soc., Ser. 2., Zool., Vol. II., p. 213) read a paper reviewing the genus, and showing reasons for including these Crag tusks in the recent genus *Trichechus*; but retaining for them the specific designation *T. Huxleyi*. He pointed out also that the English Crag tusks could not be referred to either *Alachtherium Cretsi* or *Trichecodon Koninckii*, both of which had been established on parts of skeletons without tusks, whilst *T. Huxleyi* had been founded on tusks alone, and moreover the latter has the priority, even if these Belgian forms should prove to be identical with the Suffolk species.

Some of the Crag tusks are much compressed, as shown by specimens in the Museum of Practical Geology; and Mr. Frank H. Harris, of Abingdon, has a portion of a small flattened tusk, from the Red Crag of Foxhall, probably of a young specimen, which is provisionally referred to the present species. It is about 80 mm. long, 31 mm. from back to front, and 16 mm. wide. The transverse section is elliptical, being thickest towards the back or concave margin, and narrower towards the front or convex margin. The centre of this tusk is occupied by a considerable area of globular dentine.

Trichechus Huxleyi is chiefly known by specimens from the Nodule-bed of the Red Crag of Suffolk; it has also been recognised in the Forest-bed near Cromer (Mem. Geol. Surv. Vert. Forest Bed, p. 26, 1882), and there is the proximal half of a *Trichechus* femur in the Norwich Museum, obtained by Dr. Crowfoot and Mr. E. T. Dowson in the Chillesford beds at Aldeby, which differs from the femur of the living *T. rosmarus*, and may be provisionally placed with the present species. Possibly the portion of tusk found in the Belgian Pliocene, and alluded to by Prof. Lankester, may also belong to this species.

Genus *PHOCA*, Linnæus.

PLATE II., FIG. 1, *a, b.*

A humerus from the Norwich Crag of Bramerton, which is now in the Norwich Museum, was identified, some years since by Prof. Flower as belonging to a Seal; but he did not name it specifically. It is the one alluded to by Mr. H. B. Woodward (Mem. Geol. Surv., Geology of Norwich, p. 55, 1881), and probably Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 212,

1872), when they included *Phoca vitulina* in their list of Upper Crag Mammals, also referred to this humerus; but it differs in some important characters from the humerus of that species. A radius and a tooth from the Forest-bed at West Runton have been recorded and called *Phoca* (Vert. Forest Bed, p. 29, 1882). The teeth which Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 226, 1856) thought might perhaps belong to *Phoca* have not since been recognised as such.

Portions of characteristic humeri and femora of Seals have been met with in the Nodule-bed of the Red Crag, but most of them are too much broken and rolled to admit of definite identification. Two humeri, however, in the collection of Mr. E. C. Moor, of Great Bealings, are more perfect than usual, and are described below.

PHOCA (ERIGNATHUS) BARBATA, FABRICIUS.

(Bearded Seal.)

A fine humerus, agreeing precisely with the same bone of the Bearded Seal, has been described from the Forest-bed of Overstrand (Geol. Mag., Dec. 3, Vol. VI., p. 147, 1889), and more recently a radius, apparently belonging to the same species, has been found in the same deposit. Both specimens are in the collection of Mr. A. Savin, of Cromer.

Phoca barbata is now living in the northern parts of the Atlantic and in the Arctic Seas.

PHOCA MOORI, NEWTON.

PLATE II., FIG. 2, *a*, *b*.

The greater part of a small left humerus of a Seal from the Red Crag Nodule-bed, Foxhall, four miles S.W. of Woodbridge, preserved in the collection of Mr. E. C. Moor, of Great Bealings, has been named after that gentleman (Quart. Journ. Geol. Soc., Vol. XLVI., p. 446, 1890). In form this humerus most nearly resembles that of *Phoca vitulinoides*, described by Prof. Van Beneden (Ann. Mus. Roy. Belg., Vol. I., Part i., p. 72, Plate xv., 1877), but it is much smaller and more slender.

The Museum of Practical Geology has recently obtained, through Mr. T. Jesson, a similar humerus from the Red Crag Nodule-bed of Waldringfield.

Genus PHOCANELLA, Beneden.

PHOCANELLA MINOR, *v. BENEDEN.*

To this genus and species have been referred a portion of a humerus from the Red Crag Nodule-bed, Foxhall, four miles S.W.

of Woodbridge, which, like the last, is in the possession of Mr. E. C. Moor (Quart. Journ. Geol. Soc., Vol. XLVI., p. 447, 1890), and there is a similar, but rather smaller, humerus, from the same horizon, in the Reed collection, York Museum.

Prof. Van Beneden (Ann. Mus. Roy. Belg., Vol. I., Part I., p. 71, 1877) proposed the above name for certain Seal remains found in the Belgian Pliocene (Scaldesian). The humerus of which has a remarkably triangular shaft, and with this Mr. Moor's Crag specimen perfectly agrees. Although this character is seen in Prof. Van Beneden's figures, it is much more strikingly exhibited by the casts which are preserved in the British Museum.

(Crag below?)

On the middle part of the Crag, between the upper and lower beds, Mr. E. C. Moor found a fossil humerus, and Prof. Van Beneden (Ann. Mus. Roy. Belg., Vol. I., p. 71, 1877) described it as follows:—

ANOMALUS HUMERUS.

ANOMALUS HUMERUS.

Left humerus of a seal, from the Crag, between the upper and lower beds, Mr. E. C. Moor found it, and Prof. Van Beneden described it as follows:—

ANOMALUS HUMERUS.

ANOMALUS HUMERUS.

In addition to the fossil humerus, a large portion of the skull of a seal, and a fossil humerus, were found in the same bed, and

UNGULATA.

(UNGULATA VERA.)

ARTIODACTYLA.

Genus BISON, Hamilton Smith.

Bovine remains, which are so common in Pleistocene deposits, have also been found in the Forest-bed, but very few indications have been met with in earlier Pliocene beds. Mr. H. B. Woodward obtained a bovine metatarsal from the Norwich Crag of Stoke Holy Cross (Mem. Geol. Surv., Geology of Norwich, p. 55, 1881), and Mr. E. Cavell, of Oaklands, Saxmundham, has a metatarsal from the same horizon at Easton Bavent.

The Museum of Practical Geology possesses a lower cheek tooth (Plate III., Fig. 1) from the Red Crag of Boyton agreeing with the same tooth of *Bos* or *Bison*; and similar teeth from the Red Crag of Suffolk are in the Ipswich and British Museums.

Messrs. R. and A. Bell include *Bison priscus* in the Upper Crag (Proc. Geol. Assoc., Vol. II., p. 212, 1872); but I have been unable to verify this or to find any other definite record of the species from the English Crags. It is possible, however, that the specimens above noticed may belong to *Bison*; but they are not sufficient for generic determination.

BISON BONASUS, LINNÆUS.

In the absence of definite evidence as to the form of the skull and horn-cores, the bovine remains found in the Forest-bed have been called, with doubt, *Bos primigenius* (Mem. Geol. Surv. Vert. Forest Bed, p. 47, 1882); but specimens of frontals and horn-cores, have since been found which are undoubtedly *Bison* (Geol. Mag. Dec. 3, Vol. VI., p. 146, 1889). There is no good reason for separating these specimens from the Pleistocene skulls which have been called *Bison priscus* and are now believed to be identical with the living *Bison bonasus*. It will be undesirable to retain both names, and until definite evidence of *Bos primigenius* is obtained, it will be better to refer all the bovine remains from the Forest-bed to *Bison*.

As already stated, Messrs. R. and A. Bell included *Bison priscus* in their Upper Crag list; but one can hardly accept this without verification, although the specimens alluded to above as bovine may perhaps belong to *Bison*.



Bison bonasus has been found abundantly in Pleistocene deposits in Britain and on the continent of Europe. A form indistinguishable from it occurs in beds of approximately the same age in Arctic North America (Lydekker, Cat. Foss. Mamm. Brit. Mus., Part ii., p. 25, 1885), and we have evidence of its occurrence in the Cromer "Forest Bed."

Bison bonasus still survives in Central Europe.

Genus **OVIBOS**, Blainville.

OVIBOS MOSCHATUS, ZIMMERMANN.

(*Musk Ox.*)

Prof. W. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXXIX., p. 575, Woodcut, 1883) described a portion of the skull of a Musk Ox which had been found at Trimingham, and which there is every probability came from the "Forest Bed." The specimen was found by a fisherman, and formed part of the collection of the late Rev. F. Buxton.

A second specimen preserved in the University Museum of Zoology and Comparative Anatomy at Cambridge, was afterwards noticed by the same author (Quart. Journ. Geol. Soc., Vol. XLI., p. 242, 1885), and believed to be of Forest-bed origin, although it had apparently been dredged from the North Sea.

The occurrence of *Ovibos moschatus* in British Pleistocene beds has been recorded by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 127, 1856), by Prof. Boyd Dawkins (Brit. Pleist. Mamm. Pal. Soc., 1872), and by Mr. W. Davies (Geol. Mag. Dec. 2., Vol. VI., p. 246, 1879). Its geographical range in Pleistocene times was throughout the northern parts of Europe, Asia, and America. It is now living in Arctic North America and Greenland.

Genus **CAPROVIS**, Hodgson.

CAPROVIS SAVINII, NEWTON.

(Vert. Forest Bed, p. 49. PLATE X.)

The remarkable horn-core and frontal bone to which the above name was given was obtained from the Forest-bed at Overstrand, near Cromer, and is in the collection of Mr. A. Savin. Nothing has since been found which would throw more light upon the structure of this peculiar form.

Genus ANTILOPE, Pallas.

PLATE III., Figs. 2, 3, 4, 5.

There are in the Museum of Practical Geology three large molar teeth from the Red Crag Nodule-bed, an upper and a lower from Woodbridge, and a last lower from Sutton, which I am unable at present to determine generically. In size these teeth agree with those of a large Ox, but the crowns are shorter than in any *Bos* or *Bison*, in the same stage of wear, with which I have been able to compare them. The upper tooth (Plate III., fig. 2) has an inner pillar which stands separate and would remain so until the tooth was worn nearly to its base. This pillar is about three-fourths of an inch high and is only just beginning to wear. In the lower tooth (fig. 3) the inner pillar is more closely pressed into the median groove of the tooth, much more slender, about five-eighths of an inch high, and has not yet come into wear. These teeth cannot be referred to *Cervus* or *Alces*, both of which occur in the Pliocene, the crowns being too high and the inner pillar too strongly developed. It seems most probable that they belonged to some large Antelopine genus and provisionally they are called *Antilope*.

It will be convenient to notice here a small lower cheek tooth (Plate III., fig. 5) of a ruminant, from the Nodule-bed of the Red Crag of Boyton, in the Museum of Practical Geology; this has the crown much too long for *Cervus*, and in fact must have belonged to some "cavicorn" ruminant about the size of a sheep, goat, or small antelope; it might have belonged to such a form as the *Gazella anglica*, which occurs in the Norwich Crag, but without better evidence one can scarcely suggest the occurrence of that species in the Red Crag.

Genus GAZELLA, Blainville.

GAZELLA ANGLICA, NEWTON.

PLATE III., FIG. 6, a, b, c.

The above name was proposed for a horn-core and frontal bone in the Museum of Practical Geology, which was obtained by Mr. H. B. Woodward from the Norwich Crag of Thorpe, and described before the Geological Society (Quart. Journ. Geol. Soc., Vol. XL., p. 280, 1884). Two other similar specimens were noticed at the same time and referred to the same species; one of these, also from the Norwich Crag of Thorpe, was presented to the Museum of Practical Geology by Dr. A. King, and the other was in the British Museum, S. Kensington, labelled "Norwich Crag, Norfolk, Wigham Collection." There is another similar example from the same horizon at Horstead, in the Randal Johnson Collection, preserved in Mr. J. J. Colman's Museum at Corton, near Lowestoft; and the British Museum has a tibia which may belong to this species.

M. C. Depéret (Bull. Soc. Géol. France, Ser. 3, Vol. XII., p. 251, Plate viii., f. 2, 1884) described a maxilla, with four cheek teeth in place, from the middle Pliocene of Bourbon, in the Bravard collection, as *Gazella borbonica*, and with this associated a portion of a skull and horn-core from a similar horizon at Perrier. The last-named specimen is very similar to the English *G. anglica*, but without a comparison of the specimens this cannot be decided; and, moreover, it is by no means certain that the skull from Perrier belongs to the species *G. borbonica*, which was established on the series of teeth from Bourbon.

SMALL RUMINANT. ? GENUS.

PLATE III., FIGS. 7, 8, a, b.

The Museum of Practical Geology possesses a small metatarsal bone and a first phalanx, presented by Col. Alexander, which is said to be from the Coralline Crag of Gedgrave. In size the bones agree very closely with those of *Moschus moschiferus*, and the lower end of the metatarsal has a similar expansion, but the upper part does not exactly agree, being less flattened from side to side.

The surface of these bones is much denuded, and they are very friable, like certain other bones from the Coralline Crag, and are not phosphatised, like specimens from the Nodule-bed below the Red and Coralline Crags.

Mr. E. Cavell, of Saxmundham, has a similar first phalanx from the Norwich Crag of Easton Bavent.

Genus CERVULUS, Blainville.

CERVULUS (CERVUS) DICRANOCEROS, KAUP.

PLATE IV., FIGS. 8, 9.

The occurrence of this species in the Red Crag, near Sutton, was first pointed out by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 224, 1856), and one of the figures given (p. 234, fig. 14a) agrees so well with Kaup's example (Ossem. Foss. Darmstadt, Plate xxiv., fig. 3c) that one can scarcely do otherwise than accept this determination, especially if *C. anoceros*, Kaup (*loc. cit.*, fig. 2), and *C. trigonoceros*, Kaup (*loc. cit.*, fig. 4), are accepted as synonyms of the present species, which has been done by Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXXIV., p. 403, 1878), and by Mr. R. Lydekker in the British Museum (Cat. Foss. Mam., part 2, p. 117, 1885). Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXXIV., p. 413, 1878) would refer the specimens figured by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 234) to *C. suttonensis*, but the

greater length of beam before bifurcation and the nearly equal size of the two branches above this division in Sir R. Owen's figure 14a, are unlike these parts in *C. suttonensis*.

Cervulus dicranoceros is only known in Britain from the Nodule-bed of the Red Crag. Sir R. Owen's specimen was from near Sutton, and there are two examples of this form in the British Museum (M. 1617) from Felixstow. Other specimens from the same horizon, preserved in the Museum of Practical Geology, at Ipswich and elsewhere, having the bifurcation some distance from the burr and the two branches sub-equal in size, are also taken to represent the species in the Red Crag. Messrs. R. and A. Bell include *C. dicranoceros* in the Coralline Crag list, but I have been unable to verify their record. Kaup's type specimens were from the Miocene of Eppelsheim, and from no other locality on the continent of Europe does this species seem to have been recognised.

Genus **CERVUS**, Linnæus.

Cervine remains are of frequent occurrence in Pliocene strata, and the Forest-bed is especially rich in antlers, unfortunately more or less broken, which have formed the basis for the establishment of numerous species.

The cervine teeth from the Red Crag (Plate III., figs. 8, 9) are often beautifully preserved, and several jaws have been found in the Forest-bed ; but these, as well as the bones of the skeleton which have been discovered, cannot at present be correlated with the antlers, and are therefore simply referred to the genus *Cervus*.

CERVUS ARDEUS, CROIZET & JOBERT.

PLATE IV., FIG. 6.

Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871) includes *Cervus ardeus* in the list of Mammals from the Norwich Crag of Thorpe, in Mr. Fitch's collection, and on this authority it has been quoted by other writers (Woodward, Mem. Geol. Sur., Geology of Norwich, p. 55, and R. and A. Bell, Proc. Geol. Assoc., Vol. II., p. 212, 1872). Although I have been unable to find this specimen in Mr. Fitch's collection, I am able to corroborate its occurrence at this horizon by a specimen from the same Crag Pit, presented to the Museum of Practical Geology by Dr. Arthur King, which agrees closely with the figure of the antler of this species given by MM. Croizet and Jobert (Ossem. Foss., Puy de Dome, Pl. i., fig. 1, and Plate ii., fig. 2, of the second series of plates of Cervidæ. See also Depéret, Bull. Soc. Géol. France, Ser. 3, Vol. XII., p. 225.) This specimen is a left frontal with the basal portion of an antler. A part of the frontal suture

being preserved, the width of the forehead is seen to have been about four inches (100 mm.) when entire. The pedicle of the antler is about 40 mm. long, 125 mm. in circumference, and nearly round. The burr is set a little obliquely on the pedicle, although now rather worn, the deep pits show it to have been strongly developed, its present circumference is 165 mm. The beam, at first round, becomes flattened and gives off its first tyne from the front and outer part, at about 60 mm. above the burr, and in this region the upper surface of the beam begins to curve downwards as in Croizet and Jobert's figure.

In Britain *C. ardeus* has only been found in the Norwich Crag of Thorpe. In France its remains have been recorded from the Upper Pliocene of Mont Perrier near Issoire (see Vert. Forest Bed, p. 63.)

CERVUS BOVIDES.

Now referred, by Prof. Boyd Dawkins, to *Alces latifrons*.

CERVUS CARNUTORUM, LAUGEL.

PLATE IV., FIG. 3.

This species, which was well figured by Gervais (Zool. Pal. Gen., Plate xvi., fig. 4, 1867-69) from a specimen found in the Pliocene of Saint Prest, was first noticed as a British form by Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXVIII., p. 409, 1872). Three specimens are now known from the Norwich Crag (Chillesford Beds) (*vide* Vert. Forest Bed, p. 53), but the example which has been quoted as from the Forest-bed was dredged off the Norfolk coast, and its horizon is therefore uncertain.

CERVUS DAWKINSI, NEWTON.

The specimen to which the above name was given (Mem. Geol. Surv. Vert. Forest Bed, p. 54, 1882) forms part of the King collection in the Museum of Practical Geology, and was obtained from the Forest-bed. It was at one time included with the species *C. verticornis* (Quart. Journ. Geol. Soc., Vol. XXVIII., p. 405, 1872); Prof. Boyd Dawkins (Pal. Soc., 1886) would now unite with it *C. Fitchii* and *C. Gunnii* (Vert. Forest Bed, pp. 56 and 57). I cannot follow Prof. Boyd Dawkins in this instance; for I am unable to satisfy myself that the two forms which he figures (*loc. cit.*, Plate ii.) can belong to one species, although they are undoubtedly much alike, as I pointed out when

describing the species. At that time, however, I omitted to call attention to a point of structural difference, which is more important, as it seems to me, than the presence or absence of a brow-tyne. The difference alluded to is well shown in Prof. Boyd Dawkins' plate, and it is the variation in the plane of obliquity of the burr. The plane of palmation of both antlers, it will be seen, is represented as the same as that of the plate itself. The obliquity of the burr of Fig. 1 is thus well seen; but, in order to shew that of fig. 2, it has been necessary to give another view of the base of the antler turned half way round. Thus when the antler of *C. Dawkinsi* (fig. 1) was fixed to the skull the plane of its palmation would be nearly vertical; while in *C. Fitchii* (Fig. 2) the palmation would be nearly at right angles to this. I am not aware that in any species of deer, antlers one third larger than a previous growth, assume so different a direction upon the skull, as is indicated by this variation in the plane of obliquity of the burr.

Cervus Gunnii may very well be united with *C. Fitchii* (see p. 28).

C. Dawkinsi is only known from the Forest-bed of Norfolk.

CERVUS ELAPHUS, LINNÆUS.

(*Red Deer.*)

PLATE IV., FIG. 14.

At the time when the Survey Memoir (Vert. Forest Bed, p. 55, 1882), was published, there was much doubt as to whether certain portions of antlers from the Forest-bed were those of *Cervus elaphus*; but since then better specimens have been found, and one from Kessingland, belonging to the late Mr. Backhouse of York, was determined by Mr. W. Davies, of the British Museum, in 1885, to be that of *C. elaphus*. Dr. Crowfoot, of Beccles, has another undoubted specimen (Plate IV., fig. 14), from the "peaty bed" at Kessingland; and several fragments of antlers previously known may now be referred to this species.

These Forest-bed specimens are the earliest record of *C. elaphus*, a species which is by no means uncommon in Pleistocene deposits, and is now living in the temperate regions of Europe.

CERVUS ETUERIARUM, CROIZET & JOBERT.

PLATE IV., FIGS. 4, a, b, 5.

A specimen (Plate IV., fig. 5) in the King collection, from the Forest-bed of Cromer, now in the Museum of Practical Geology, has been referred with doubt to this species (Vert. Forest Bed, p. 55, 1882). This is the specimen alluded to as

Rusa by Dr. Falconer (Pal. Mem., Vol. II., p. 480, 1868). *C. etuieriarum* is found in the Pliocenes of France (Croizet & Jobert, Ossem Foss., Puy-de-Dôme, Cervidæ, Sec. 2, Plates vi. bis, and vii., 1828; also Depéret, Bull. Soc. Géol. France, Ser. 3, Vol. XII., p. 265, 1884), and Dr. Forsyth Major (Quart. Journ. Geol. Soc., Vol. XLI., p. 2, 1885) records it with some doubt from the Pliocene Beds of the Val d'Arno.

Mr. Savin possesses a nearly perfect antler (Plate IV., fig. 4, *a*, *b*), with three tynes, from the Forest-bed of East Runton, which is more slender and less curved than that in the King collection, but is believed to belong to this species.

CERVUS FALCONERI, DAWKINS.

PLATE IV., FIG. 7, *a*, *b*.

This species was established by Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXIV., p. 516, 1868), for a specimen in the British Museum, No. 33,507 (Cat. Foss. Mamm., Part ii., p. 91, 1885), from the Norwich Crag, Norfolk. Certain basal portions of antlers from the Red Crag Nodule-bed of Suffolk, one of which is in the British Museum, No. 35,857, were also included in the same species.

Cervus Falconeri is nearly allied to *Cervus dama* and *C. Brownii* but differs from them in having the brow tyne removed further from the burr, and given off from the beam in a plane at right angles to the second and third tynes. The distance between the first and second tynes is less than that between the second and third; the palmation also is much less than in *C. dama*.

CERVUS FITCHII, GUNN, MS.

(= *C. Gunnii*, NEWTON).

The late Mr. J. Gunn proposed this name for a large palmated antler from the Forest-bed of Bacton, which is now in the Norwich Museum, and had it lithographed, but the plate has not been published. The species was noticed in the Memoir of the Geological Survey (Vert. Forest Bed, p. 56, 1882). Prof. Boyd Dawkins (Pal. Soc. Pleist. Mamm., p. 7, 1886), has proposed to unite this form and *C. Gunnii* (Vert. Forest Bed, p. 57) with *C. Dawkinsi* (*ibid.*, p. 54), but for reasons given under the last species, p. 26, I am unable to do this; at the same time, having again compared these forms in the light of Prof. Boyd Dawkins' Memoir, I think it will be desirable to unite *C. Gunnii* with the present species, and should include also Mr.

Savin's specimen, figured by Professor Boyd Dawkins on Plate iii., fig. 1. *Cervus Fitchii* is only known from the Forest-bed of Norfolk.

CERVUS GIGANTEUS ? BLUMENBA CH.

(=C. MEGACEROS, HART.)

(*Irish Elk.*)

PLATE IV., FIG. 11.

The beam of a large antler from the Red Crag of Suffolk was figured and thus described by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 226, fig. 18, 1856) as *Megaceros hibernicus*. "In the relative size and position, immediately above the burr, of the origin of the brow-snag, in the absence of a second snag at the distance above the brow-snag where such second snag arises in the *Strongyloceros spelæus*, in the commencing flatness of one side, and expansion of the beam at the broken end 11 inches from the burr, this Crag fossil resembles the corresponding part of the antler of the great Irish Deer (*Megaceros hibernicus*). The circumference of the burr is 11 inches. In colour and ponderosity this remarkable fossil agrees with the ordinary fossils of the Red Crag."

I have been unable to discover this antler (see Plate IV., fig. 11), and therefore can only give it on Sir R. Owen's authority. The figure and description certainly agree very well with the stem of the Irish Elk's antler; but it seems doubtful whether it really belonged to this species.

The occurrence of *C. giganteus* in the Norfolk Forest-bed (Vert. Forest Bed, p. 58, 1882) is so very doubtful that it has been decided no longer to include it in the fauna of that horizon. In Pleistocene deposits it has been found at many localities in Western Europe, as well as in England and in the bogs of Ireland. M. Depéret quotes this species from the Pliocene of Saint Prest. (Vert. Plioc. d'Europe, Ann. Sci. Géol., Vol. XVII., p. 261, 1885).

CERVUS POLIGNACUS, ROBERT.

PLATE IV., FIG. 12.

The only British specimens which can be referred to this species have been obtained from the Forest-bed of Norfolk, and possibly Suffolk (Falconer, Pal. Mem., Vol. II., p. 47-9, 1868; Newton, Vert. Forest Bed, p. 59, 1882). The specimen here figured is in the Gunn collection in the Norwich Museum.

The species was first described from specimens found in the Pliocene of central France.

CERVUS RECTUS, NEWTON.

PLATE IV., FIG. 1.

The frontal bone and base of an antler of a small Deer from the Forest-bed of Sidestrand has been described as a new species (Geol. Mag., Dec. 3, Vol. VI., p. 145, Plate v., fig. 1, 1889), and named as above. The species is characterised by the narrow forehead, long pedicle, with angular ridges running down the frontal bone, and simple upright antler, which, so far as preserved, is devoid of tynes. It is quite likely that this is a first antler, and that the adult form would be different; but I know no recent or fossil species to which it can be referred. Messrs. Woodward and Sherborn (Cat. Brit. Foss. Mamm., p. 327) place this species as a synonym of *Capreolus caprea*; but this I regard as an error, the two forms being quite unlike when the actual specimens are compared.

The type is in the collection of Mr. A. Savin, of Cromer.

CERVUS SAVINI, DAWKINS.

Among the antlers from the Forest Bed Series certain forms had long since attracted the attention of Mr. J. Gunn on account of the remarkable form of the brow-tyne, which, arising directly above, or even touching, the burr, was seen to be strikingly flattened, and the most perfect example of this tyne is the most flattened, and the broadest at its distal extremity. No specimens have yet been found with a perfect brow-tyne, and therefore it is not known how it terminated. This peculiar flattening led Mr. Gunn to think the antler was related to the Reindeer, and he has figured a fragment in his unpublished plates.

More perfect specimens have now been found and worked out by Prof. Boyd Dawkins, who has named the species after Mr. A. Savin, of Cromer, the possessor of the most perfect antler of this form yet discovered (Proc. Roy. Soc., Vol. XXXVIII., p. 345, 1885, and Pal. Soc. for 1886, p. 11, Plate iii., fig. 3, 1887). Dr. Crowfoot, of Beccles, however, has a very fine frontal with a good part of both antlers attached; and portions of similar antlers are to be found in all collections of Forest-bed Mammals.

Mr. Savin's specimen exhibits the peculiar flattening of the base of the brow-tyne; but, unfortunately, Prof. Boyd Dawkins' figure (Plate III., fig. 3) does not show this satisfactorily, which is the more to be regretted, because it gives a wrong idea of the form of the tyne, which could scarcely have terminated in the

manner depicted by the artist in the restored outline ; and makes the resemblance between this and figure 4 seem greater than it really is. Figure 5, on the same plate, gives some idea of the compression of the brow-tyne at its base. I have examined a large number of specimens of this species, probably nearly all that have been found, and they are remarkably uniform in character, especially as regards the flattened form of the brow-tyne, even in examples differing much in size ; and I cannot therefore satisfy myself that the specimens represented by figures 2 and 4 of Prof. Dawkins' Memoir should be included in the same species.

At present *Cervus Savini* is only known from the Forest-bed of Norfolk and Suffolk.

CERVUS SEDGWICKII, FALCONER.

The complex antlers to which Dr. Falconer gave the name of *Cervus Sedgwickii* (Pal. Mem., Vol. II., p. 472, Plate 37, 1868) have only been found in the Forest-bed in Britain (Mem. Geol. Surv., Vert. Forest Bed, p. 60, 1882), but the same form, apparently, occurs in the Pliocene beds of Italy, and has there been called *C. dicranios* (Nesti, MS. Rütimeyer, Abh. schweiz. pal. Ges., Vol. VIII., 1880).

CERVUS SUTTONENSIS, DAWKINS.

PLATE IV., FIG. 13.

This species was established by Prof. Boyd Dawkins (Quart. Journ. Geol. Soc., Vol. XXXVI., p. 411, 1878) for the reception of certain portions of antlers found in the Crag of Norfolk and Suffolk, in which "The base of the antler is cylindrical, and the burr is very strongly marked and circumscribed, the base in a plane oblique to the axis of the beam, which is traversed by clearly defined deep grooves. These, however, are very generally worn away by the action of water. The beam runs straight away from the burr, and is cylindrical, except at the point, where the brow-tyne springs immediately above the base. At that point there is a smooth triangular area, slightly convex or flat on the superior surface and slightly concave on the inferior, and which is free from the grooves which occur on the rest of the antler. The brow-tyne is slightly oval in section, and * * * * forms an acute angle with the beam, as in *Axis* and *Rusa*, and is very much smaller in every dimension."

A large specimen, $8\frac{1}{2}$ inches long (Plate IV., fig. 13) in the York Museum, from the Red Crag Nodule-bed, which doubtless belongs to this species, has the beam rather more curved than in the type specimen.

Prof. Dawkins proposed to include in this species the specimens referred by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 224, figs. 14, 16) to *C. dicranoceros*, Kaup; but it seems to me that fig. 14a agrees better with Kaup's species (see remarks under *C. dicranoceros*, p. 24).

Cervus suttonensis is at present known from the Red Crag Nodule-bed of Suffolk; Prof. Boyd Dawkins also gives it as from the Norwich Crag of Horstead, in Mr. Gunn's collection, and from the Pliocene of Montmarle (Aire), France.

CERVUS TETRACEROS, MACKIE.

PLATE IV., FIG. 2.

A number of shed antlers from the Pliocene beds of Peyrolles in the Puy de Dôme, now preserved in the British Museum, were labelled *Cervus tetracroceros* by M. Bravard; but he published no account of them. In 1861, Mr. Mackie (Geologist, Vol. IV., p. 465, 1861) described these specimens, using Bravard's MS. name; and in 1878 Prof. Boyd Dawkins again described them (Quart. Journ. Geol. Soc., Vol. XXXIV., p. 416, 1878), modifying the name to *C. tetraceros*. It was not, however, until the year 1883 that this form was first recognised as British, when Prof. B. Dawkins (*ibid.* Vol. XXXIX., p. 579) detected in the Museum of Practical Geology a specimen from the Forest-bed of East Runton (Plate IV., fig. 2), as well as fragments in the collection of Mr. Backhouse of York, also from the Forest-bed.

CERVUS VERTICORNIS, DAWKINS.

A portion of a large antler from the Forest-bed was noticed by Dr. Falconer in 1863 (Pal. Mem., Vol. II., p. 479, 1868), and afterwards named by Prof. Boyd Dawkins (Quart. Journ. Geol., Vol. XXVIII., p. 405, 1872) *Cervus verticornis*, he also further illustrated the species in 1887 (Pal. Soc., p. 22). Remarks on the species will be found in the Memoir of the Geological Survey (Vert. Forest-bed, p. 61, 1882), where one specimen is separated as a distinct species, and named after Prof. Dawkins.

Cervus verticornis has been found in some abundance in the Forest-bed of Kessingland and Pakefield as well as other localities in Norfolk and Suffolk. Prof. Boyd Dawkins (Pal. Soc., 1887) has also identified an antler from the Red Crag of Trimley, near Felixstow, in the British Museum (No. 45,929, Cat. Foss. Mamm., Part iii., p. 93, 1885) as belonging to this species.

Genus **ALCES**, Hamilton Smith.**ALCES LATIFRONS**, JOHNSON.(=? **CERVUS BOVIDES**, GUNN, MS.)

Mr. Randall Johnson obtained a large piece of an antler from the Forest-bed at Hashoreugh, which he described (Annals, Ser. 4, Vol. XIII., p. 1, 1874) as a new species, and named *Cervus latifrons* (Mem. Geol. Surv. Vert. Forest Bed, p. 58, 1882). The specimen is now in the Museum of Mr. J. J. Colman at Certon. Prof. Boyd Dawkins (Pal. Soc. for 1886-1887) has shown good reason for removing this species from the genus *Cervus* to that of *Alces*; and with this I quite agree, as well as with placing the two antlers in Mr. Savin's collection (Pal. Soc. for 1886, Plate i., figs. 1 and 5) in the same genus; but the much greater length of beam before palmation, in the two specimens last mentioned, makes me doubtful as to their belonging to the same species.

The broken condition of the specimen named *C. bovides* by Mr. Gunn (see Memorials of John Gunn, 1891. Cervidae, Pl. i., fig. A.), and of the three figured by Prof. Boyd Dawkins (*loc. cit.*, figs. 2, 3, 4) prevents our knowing what was the length of their beams; but Prof. Boyd Dawkins has perhaps done wisely in referring them provisionally to the genus *Alces*. The tapering form of the specimen figured by Mr. Gunn, however, is so unlike either of the examples of *Alces* antler figured by Prof. Dawkins, although he says (*loc. cit.*, p. 4) this tapering "is the rule rather than the exception in the whole series," that I do not feel at all satisfied as to the propriety of referring it to *Alces latifrons*; nevertheless to prevent confusion, and awaiting further evidence, these four specimens may be included in this species.

At present *Alces latifrons* is only known from the Forest-bed of Norfolk and Suffolk, from Weybourn Beds near Cromer, and, according to Prof. Dawkins, from the Dogger Bank.

Genus **CAPREOLUS**, Hamilton Smith.**CAPREOLUS CAPREA?** GRAY(=? **CERVUS CAPREOLUS**, LINNEUS.)

(Roebuck.)

PLATE IV., FIG. 10.

Antlers of this species have been recorded from the Norfolk Forest-bed (Mem. Geol. Surv., Vert. Forest Bed, p. 52, 1882), but there is some little doubt as to their being from that horizon.

The specimen from Bacton alluded to by the Rev. Chas. Green (History of Bacton, pp. 59 and 60, with Plate, 1842) as *Anoplotherium*, was afterwards said by Sir R. Owen (Brit. Assoc. Rep.

for 1842 (1843), pp. 57 and 74) to have been made up of bones from several different animals, but chiefly parts of a ruminant closely resembling the Roebuck. It may be that the remains were from the Forest-bed, but the horizon as well as the determination is uncertain, and the specimen has since been destroyed.

Capreolus caprea has been recorded from Caves and other Pleistocene deposits (Dawkins, Quart. Journ. Geol. Soc., Vol. XXV., p. 192, 1869) as well as from the Fens and Prehistoric strata. It is now living in the temperate zones of Europe.

Genus **XIPHODON**, Cuvier.

XIPHODON PLATYCEPS, FLOWER.

The greater part of a skull, said to be from the Red Crag of Suffolk, preserved in the Museum of the Royal College of Surgeons, has been described by Prof. Flower (Proc. Zool. Soc. 1876, p. 3, Plate i.), and referred provisionally to Cuvier's genus *Xiphodon*, with the new specific name of *X. platyceps*. The specimen is about the size of the skull of a small sheep, and is remarkable for "the breadth and flatness of the frontal region between the orbits." Unfortunately all the teeth are absent, and its dental characters consequently unknown.

The exact age of this skull is uncertain, but the matrix appears to approximate most nearly to that of the so-called "box-stones" of the Suffolk Crag.

Genus **HIPPOPOTAMUS**, LINNÆUS.

HIPPOPOTAMUS AMPHIBIUS, LINNÆUS.

(= *H. major*, OWEN.)

The remains of *Hippopotamus* from the Forest-bed were first recorded by S. Woodward (Geology of Norfolk, p. 46, 1833), and a splendid lower jaw was figured and described by Sir R. Owen (Brit. Foss. Mamm., p. 399, 1846). Other specimens from the same horizon have been found at several localities in Norfolk and Suffolk (Vert. Forest Bed, p. 42, 1882), but I have been unable to verify Mr. H. B. Woodward's record from the Norwich Crag. (Geology of Norwich, p. 55, 1881.)

Since the year 1846 the British fossil *Hippopotamus* has been generally called *H. major*, Owen, but most authorities are now agreed that these remains cannot be separated from the *Hippopotamus amphibius*, now living in the Nile (Cat. Foss. Mamm. Brit. Mus., Part ii., p. 277, 1885).

The remains of *H. amphibius* occur in the Pleistocene deposits of this country as well as in the Forest-bed. The species also

occurs in the Pliocene of France and Italy; and is now living in Africa south of the Sahara.

Genus SUS, Linnæus.

The teeth of Pigs from the Red Crag of Suffolk, which were known in the year 1846, were not at that time specifically named by Sir R. Owen (Brit. Foss. Mamm., p. 427), but in 1856 (Quart. Journ. Geol. Soc., Vol. XII., p. 222) he referred them to two species, *Sus palæochærus*, Kaup, and *S. antiquus*, Kaup. Prof. Lankester in 1864 (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV., p. 359) quoted the same two species; but in 1870 (Quart. Journ. Geol. Soc., Vol. XXVI., p. 510) he seems to have doubted the correctness of this identification as he merely gives *Sus* sp. More recently Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part ii., pp. 268 and 273, 1885; Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886), has thought it possible that the larger teeth may have belonged to *Sus erymantheus*; at the same time he retains provisionally the name of *Sus palæochærus* for the smaller Pig's teeth of the Red Crag.

Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 208, 1872) give *Sus arvernensis* as a Red Crag form; but there is no sufficient reason for acknowledging a third species in the Crag. Mr. J. Gunn (Geol. Mag., Vol. VI., p. 237, 1869) recorded the occurrence of Pig in the Coprolite bed below the Coralline Crag, at Sutton.

There are two portions of lower tusks of *Sus* from the Red Crag in the Reed collection, York Museum, one from Woodbridge, and the other from Waldringfield, and there is an incisor in the Canham collection at Ipswich.

SUS ANTIQUUS? KAUP.

PLATE III., FIGS. 11, a, b, 12, a, b.

The larger Pig's teeth from the Red Crag, which were referred by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 222, 1856) to *Sus antiquus*, are provisionally retained in this species. Although it is possible they may belong to *S. erymantheus*, as indicated by Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886), yet it is not certain that such an allocation would be correct, and of two uncertain names it seems best to keep the one which has been so long in use, rather than introduce another equally uncertain. *Sus antiquus* is only known in Britain from the Nodule-bed of the Red Crag of Suffolk. The type described by Kaup was from Upper Miocene Beds at Eppelsheim. *Sus erymantheus* was found in the Lower Pliocene strata of Pikermi.

SUS PALÆOCHÆRUS, KAUP.

PLATE III., FIGS. 13, 14.

The smaller Pig's teeth from the Nodule-bed of the Red Crag of Suffolk, which were identified as *Sus palæochoerus* by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 222, 1856), are provisionally kept with that species; and this determination is in accordance with the opinions of Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886).

Sus palæochoerus was described from specimens found in the Upper Miocene of Eppelesheim.

SUS SCROFA, LINNÆUS.

(Wild Boar.)

(Vert. Forest Bed, p. 43. PLATE VI., FIGS. 4, 4a.)

So far back as the year 1840 (Lyell, Phil. Mag., Ser. 3, Vol. XVI., p. 345) the remains of the common Pig, *Sus scrofa*, were known to occur in the Norfolk Forest-bed, and since then several specimens have been found (Owen, Brit. Foss. Mamm. p. 429, 1846), some of which are well preserved and show no characters by which they can be separated from the living form.

Sus scrofa is also known from Pleistocene and Prehistoric deposits, and is now living in the temperate zone of Europe.

PERISSODACTYLA.

Genus EQUUS, Linnæus.

EQUUS CABALLUS, LINNÆUS.

(Vert. Forest Bed, p. 30. PLATE VII., FIGS. 1-8.)

In the Survey Memoir Prof. Rütimeyer's name of *Equus caballus fossilis* was used for the fossil horses, the remains of which could not be distinguished from the recent forms; it is now thought better to follow Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., part iii., p. 73, 1886), and to refer these fossils to the recent species *Equus caballus* until such time as they can be shown to be specifically distinct. Prof. Flower (Cat. Vert. Roy. Coll. Surg., part ii., p. 408, 1884), in referring similar specimens, places a query after *E. caballus*?

The equine remains from the Norwich Crag, noticed by Sir R. Owen (Brit. Foss. Mamm., p. 390, 1846), in Mr. Fitch's collection, and referred to *E. fossilis*, are provisionally included with *E. Stenonis*, which is known to occur in these beds.

A horse's tooth from the Red Crag of Bawdsey, Suffolk, was noticed by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 223, fig. 12, 1856), and provisionally referred to *E. plicidens*. This specimen is in the British Museum (No. M. 2,704), and Mr. R. Lydekker says (Cat. Foss. Mamm. Brit. Mus., part iii., p. 90, 1886) it is not like *E. Stenonis*, and may possibly belong to *E. caballus*; provisionally it is kept with the latter species.

There is another large upper equine molar from the Red Crag of Felixstow in the York Museum, but it is too much broken for specific determination.

Numerous teeth, which cannot be distinguished from those of *E. caballus*, have been obtained from the Forest-bed (Vert. Forest Bed, p. 30), and similar teeth are common in Caves and other Pleistocene and Prehistoric deposits in this country, on the continent, and in Arctic America.

EQUUS STENONIS, COCCHI.

PLATE V., FIG. 7, a, b.

The occurrence of this species in the Forest-bed, and in the Norwich Crag of Thorpe, has been noticed in the Survey Memoir (Vert. Forest Bed, p. 35, 1882), a specimen from the latter locality being in the Museum of Practical Geology (Plate V., figs. 7, a, b.).

The remains of *Equus* from the Norwich Crag in Mr. Fitch's collection, noticed by Sir R. Owen (Brit. Foss. Mamm., p. 390, 1846), and referred to *E. fossilis*, are provisionally included in this species.

Equus Stenonis occurs in Upper Pliocene beds in Italy and in France.

Genus HIPPARION, Christol.

HIPPARION GRACILE, KAUP.

PLATE VI., FIGS. 8, a, b; 9, a, b.

Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 223, 1856) was the first to recognise certain teeth from the Red Crag of Suffolk as probably belonging to *Hipparium*; and Prof. Lankester (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV. p. 359, 1864, and Quart. Journ. Geol. Soc., Vol. XXVI., p. 510, 1870) also noticed the occurrence of this genus in the Red Crag. Messrs. R. and A. Bell (Geol. Assoc., Vol. II., p. 208, 1872) include this form in their list of Middle or Red Crag Mammals under the name *Hippotherium gracile*, and this appears to be the earliest record of the species in Britain. Several teeth from the Red Crag of Suffolk are included by Mr. Lydekker under

this name (Cat. Foss. Mamm. Brit. Mus., part iii., p. 54), and similar teeth are to be found in nearly all collections of Red Crag Mammals.

Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 212), give this genus also from the Upper or Norwich Crag, but I am unable to corroborate this; and possibly limb bones which would now be referred to *Equus* have been called *Hipparium*.

It appears, therefore, that in Britain *Hipparium gracile* is only known from the Red Crag Nodule-bed; but the species has a wide distribution, having been found in strata of Upper Miocene or Lower Pliocene Age in France, Germany, Greece, Spain, N.W. Persia, and Algeria.

Genus RHINOCEROS, Linnæus.

The Rhinoceros teeth from the Red Crag which were known to Sir R. Owen in 1856 (Quart. Journ. Geol. Soc., Vol. XII., p. 217), he, with some hesitation, referred to *R. Schleiermacheri*, and this name has been generally used for the species of *Rhinoceros* occurring in the Red Crag; Prof. Lankester, however, (Quart. Journ. Geol. Soc., Vol. XXVI., p. 510, 1870) alludes to the possibility of *R. etruscus* and *R. megarhinus* also being Crag species. More recently Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886) has pointed out that the strong inner cingulum present in the specimens figured by Sir R. Owen (*loc. cit.*, p. 231) and now in the British Museum (Cat. Foss. Mamm., part iii., p. 149, 1886), makes these teeth agree better with *R. incisivus*, Kaup, and this, I think, is more likely to be correct; but at the same time some of the upper premolars found in the Red Crag are devoid of an inner cingulum, and these I take to represent *R. Schleiermacheri*.

Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 118, 1871) has recorded the finding of two *Rhinoceros* teeth in the Nodule-bed below the Coralline Crag at Sutton, but the species of these is uncertain.

RHINOCEROS INCISIVUS, KAUP.

PLATE VI., FIGS. 1, a, b, 2, 3.

To this species are referred the *Rhinoceros* teeth from the Red Crag Nodule-bed of Suffolk figured by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 231, 1856), and alluded to by Mr. Lydekker (*ibid.*, Vol. XLII., p. 366, 1886, and Cat. Foss. Mamm. Brit. Mus., Part iii., p. 149, 1886) as well as other upper premolar teeth found in various collections, which have a strongly developed inner cingulum.

The upper true molars and lower cheek teeth of the Crag *Rhinoceros* are much less certainly determinable.

Rhinoceros incisivus seemed to have lived in Europe from the Middle Miocene to the Lower Pliocene.

RHINOCEROS SCHLEIERMACHERI, KAUP.

PLATE VI., FIG. 4 a, b.

Although the specimens of *Rhinoceros* upper cheek teeth referred by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 217 and 231, 1856) to this species are probably more correctly identified by Mr. Lydekker with *R. incisivus* (Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886), yet there are specimens of upper premolars from the Nodule-bed of the Red Crag of Suffolk without any inner cingulum, and these I think should still be referred to *R. Schleiermacheri*; the distribution of this species is much the same as that of *R. incisivus*.

RHINOCEROS ETRUSCUS, FALCONER.

(Vert. Forest Bed, p. 38. PLATE VIII.)

This species was founded by Dr. Falconer (Pal. Mem., Vol. II., p. 309, 1868) for a *Rhinoceros* found in Italian Pliocene Strata, and its presence in the Forest-bed is well established. It has been suggested that some of the Red Crag *Rhinoceros* remains might belong to *R. etruscus* (Lankester, Quart. Journ. Geol. Soc., Vol. XXVI., p. 510, 1870, and Lydekker, *ibid.*, Vol. XLII., p. 366, 1886), but there is no definite evidence that such is the case.

Rhinoceros etruscus in Britain seems to have been restricted to the Forest-bed; on the continent it has been found in the Upper Pliocene of France, Spain, and Italy; and some specimens found near Rome may be of Pleistocene age.

RHINOCEROS MEGARHINUS ? CHRISTOL.

(Vert. Forest Bed, p. 40. PLATE IX., FIG. 1.)

A single upper tooth from the Forest-bed was referred by Dr. Falconer (Pal. Mem., Vol. II., p. 398, 1868) to this species, but no further evidence of its occurrence at this horizon in Britain has since been obtained (Dawkins, Quart. Journ. Geol. Soc., Vol. XXIII., p. 214, 1867). The species is met with in Caves and in the Pleistocene gravels of the Thames Valley. In Europe the same form under different synonyms has been recorded from Pliocene Beds in France, Germany, and Italy. Dr. Falconer (*loc. cit.*,

p. 310) says *R. megarhinus* (*R. leptorhinus*) occurs in the Val d'Arno upper beds, and Prof. Dawkins (*loc. cit.*, p. 214) also says the species is abundant in that locality; but Dr. Forsyth Major (Quart. Journ. Geol. Soc., Vol. XLI., p. 1, 1885) excludes it from his latest list of Val d'Arno Mammals. M. Depéret (Vert. Foss. Plioc. Roussillon, Ann. Sci. Géol., Vol. XVII., p. 177, 1885) would refer our Red Crag *Rhinoceros* to *R. leptorhinus*, Cuv. (*R. megarhinus*, Christol.). It seems open to grave doubt whether the forms called by M. Depéret *R. leptorhinus*, Cuv., would be accepted by British palaeontologists as evidence of that species (Lydekker, Geol. Mag., Dec. 2, Vol. III., p. 329, 1886). There is doubtless great difficulty in the correlation of the English and continental species of this genus, and possibly, as Prof. Dawkins seemed to think in 1865 (Nat. Hist. Rev., Vol. V., p. 403), the forms called *R. Schleiermacheri* and *R. megarhinus* may be but one species; this, however, has yet to be proved.

Genus TAPIRUS, Cuvier.

TAPIRUS ARVERNENSIS (?) DEVEZE & BOUILLET.

(= **T. PRISCUS**, OWEN.)

PLATE VI., FIG. 10, *a*, *b*, 11, *a*, *b*.

The genus *Tapirus* was first recognized as British by Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 222, 1856), certain lower and upper teeth from the Red Crag of Suffolk being referred to *T. priscus*, Kaup, and this determination has since been very generally accepted; but Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part iii., p. 3, 1886, and Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886) has noticed that the Tapir teeth from the English Crag are smaller than those of *T. priscus*, and agree better with those of *T. arvernensis* and *T. elegans*.

T. arvernensis, Dev. and Bou. (*Essai sur la Montagne de Boulade*, 1827), was the first name used for a fossil Tapir; the *T. elegans*, Pomel (*Catalogue Méthodique*, p. 84, 1853) has teeth a trifle smaller, but its title to specific distinction is very doubtful; *T. priscus*, Kaup. (1832) is said to be generally larger than *T. arvernensis*, although, judging from the measurement given by Depéret (Vert. Foss. Plioc. Roussillon, Ann. Sci. Géol., Vol. XVII., p. 180, 1885), the difference is not very great; and should the two species prove to be identical, the name *T. arvernensis* will have to be adopted.

The species of fossil Tapirs having been founded on such slender evidence, their distinctness is very doubtful, and it might have been better to let Sir R. Owen's determination of the English specimens remain for the present; but as Mr. Lydekker has made the alteration (*loc. cit.*), and the English specimens agree rather more nearly with the *Tapirus arvernensis*, this name is here adopted.

The specimens of *Tapirus* found in Britain, and now to be called *T. arvernensis*, are all derived from the Nodule-bed of the Red Crag of Suffolk. The species has also been found in Pliocene beds at Issoire, Perpignan, Montpellier, and Velay, in France, and at the same horizon in the Val d'Arno, Italy.

Tapirus priscus seems to have been restricted to the Upper Miocene; it has been found at Eppelsheim (Hesse Darmstadt), and Casino, Italy.

Genus HYRACOTHERIUM, Owen.

HYRACOTHERIUM LEPORINUM, OWEN.

PLATE V., FIG. 6.

This genus and species was founded by Sir R. Owen in 1839 (Trans. Geol. Soc., Ser. 2, Vol. VI., Part i., p. 203) for a specimen from the London Clay of Herne Bay, and further illustrated in 1846 (Brit. Foss. Mamm., p. 419). In 1865 an example from the Red Crag Nodule-bed of Suffolk was described by the same author (Geol. Mag., Dec. 1, Vol. II., p. 339, Plate x., fig. 2). Both the above specimens are in the British Museum (Cat. Foss. Mamm., Part iii., p. 11, 1886); but other examples from the same horizon have since been found, and are preserved in the Museum of Practical Geology, York Museum, and in Mr. E. C. Moor's collection at Great Bealings.

The Red Crag specimens have been almost certainly derived from the Eocene.

(SUBUNGULATA.)

Genus CORYPHODON, Owen.

PLATE V., FIG. 12, *a, b*.

Sir R. Owen (Brit. Foss. Mamm., p. 299, 1846) gave the name of *Coryphodon eocenus* for a portion of a lower jaw from the Lower Eocene of Essex, the teeth of which were something like those of the Tapir, but larger. Further light has been thrown on the genus by the finding of other specimens on the continent and in this country (Proc. Geol. Assoc., Vol. VIII., p. 250). Teeth of *Coryphodon* have been met with in the Nodule-bed of the Red Crag of Suffolk, and seem to have been first recognized by Prof. Flower (Quart. Journ. Geol. Soc., Vol. XXX., p. 6, 1874), and specimens are to be seen in the Ipswich Museum and in the Museum of Practical Geology. It is highly probable that all these Crag examples have been derived from Eocene Strata.

Genus MASTODON, Cuvier.

Sir R. Owen (Rep., Brit. Assoc., 1843, p. 219), in his report on British Fossil Mammals, referred the Mastodon teeth from the English Crags to *M. angustidens*, Kaup, and in his subsequent works (Brit. Foss. Mamm., p. 271, 1846, and Quart. Journ. Geol. Soc., Vol. XII., p. 223, 1856), adhered to this identification.

Dr. Falconer (Pal. Mem., Vol. II., 1868) made a careful study of the English and continental Mastodons, and came to the conclusion that the British forms were to be referred to *M. arvernensis*, and this decision has been accepted almost universally. Some few specimens, more recently found, indicate the existence of other species in the Red Crag.

Prof. Lankester (Geol. Mag., Vol. VI., p. 355, 1869) has given an account of a "trilophodont" Mastodon tooth from the "Suffolk Bone Bed," which was at that time in the Baker Collection at Woodbridge, and is now in the Reed Collection, York Museum. This specimen was said to have its nearest ally in the *Mastodon Borsoni*; and it is described and figured in a subsequent paper (Quart. Journ. Geol. Soc., Vol. XXVI., p. 507, 1870) with other portions of *Mastodon* teeth which were referred to *M. tapiroides*.

Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part iv., and Quart. Journ. Geol. Soc., Vol. XLII., p. 365, 1886), after studying the Mastodons in the British Museum and elsewhere, came to the conclusion that three species of Mastodon are represented in the English Crags, the commonest form being *M. arvernensis*. The specimen, which Prof. Lankester (Quart. Journ. Geol. Soc. Vol. XXVI., Plate xxxiv., fig. 1) thought to be nearest to *M. Borsoni*, Mr. R. Lydekker thinks is not a complete trilophodont tooth, but a part of a tetralophodont form, and refers it to *M. longirostris*; while the tooth which Prof. Lankester (*ibid.*, Plate xxxiv., fig. 4) called *M. tapiroides* he would name *M. Borsoni*.

Mastodon angustidens is no longer accepted as a British species.

Mastodon remains have been met with in England in the Coralline Crag (Prestwich, Quart. Journ. Geol. Soc., Vol. XXVII., p. 118, 1872, and Gunn, Geol. Mag., Vol. VI., p. 237, 1869), but more abundantly in the Red and Norwich Crags. Mr. Cavell has fragments from Easton Bawent, and it extends upwards to the "Chillesford Beds" (Bell, Proc. Geol. Assoc., Vol. II., p. 215, 1872), but not a fragment has been recognised in the Forest-bed.

In Europe and Asia the genus is known from many places, and ranges from Miocene to Upper Pliocene, while in North and South America it is represented in beds of Post-pliocene age. Dr. Falconer notices a specimen he had seen from Mexico (Pal. Mem., Vol. II., p. 74).

MASTODON ARVERNENSIS, CROIZET & JOBERT.

By far the greater number of Mastodon teeth found in the English Crags are referable to *M. arvernensis*. The species according to Dr. Falconer (Pal. Mem., Vol. II., p. 28, 1868), is characterised by the transverse ridges being each formed by two pairs of thick high mammillæ, with transverse valleys interrupted by large accessory mammillæ; while the inner and outer portions of the ridges alternate to a greater or less extent.

Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 118, 1871) includes this species among the Coralline Crag Vertebrates; but in a note gives the following quotation from Prof. Lankester (*ibid.*, Vol. XXVI., p. 497):—"A Mastodon tooth which I have seen from that situation [bed below the Coralline Crag] is not *M. arvernensis*, but belongs to the Trilophodont species." Mr. Gunn (Geol. Mag., Vol. VI., p. 237, 1869) has also noticed a Mastodon tooth from the Coprolite bed below the Coralline Crag at Sutton. One cannot, however, say to what species this specimen belonged.

Mastodon arvernensis is well known from the Norwich and Red Crags of many localities in Norfolk and Suffolk. In France it has been recorded from the Lower Pliocene at Montpellier, and from the Upper Pliocene at Mont Perrier, &c.; also from Pliocene strata in the Val d'Arno, in Germany, and in Croatia.

MASTODON LONGIROSTRIS, KAUP

To this species Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 365, 1886) has referred certain specimens from the Red Crag of Suffolk, preserved in the British Museum, and also the tooth from near Woodbridge, figured and described by Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXVI., Plate xxxiv., fig. 1, 1870) as nearly allied to, if not identical with *M. Borsoni*. This tooth, which is now in the Reed Collection, York Museum, Mr. Lydekker is convinced is a part of a tetalophodont tooth, and cannot therefore belong to the trilophodont *M. Borsoni*; and besides this, the portion preserved agrees with *M. longirostris*.

The characters by which the teeth of the present species are distinguished from those of *M. arvernensis* are pointed out by Dr. Falconer (Pal. Mem., Vol. II., p. 29, 1868) and are thus shortly given by Mr. R. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part iv., p. 62, 1886). "The columns of the cheek-teeth are separated by a deep longitudinal cleft, but are arranged in the same transverse line; the accessory tubercles are of moderate size, and one column of each of the earlier ridges wears into a distinct trefoil; the valleys are but slightly blocked, and do not contain any appreciable amount of cement."

Mr. E. Cavell, of Saxmundham, has a Mastodon tooth said to be from the Coralline Crag of Sutton (no doubt meaning the Nodule-bed beneath the Coralline Crag) which I believe belongs to this species, for it agrees with the above characters and closely resembles part of the tooth figured by Kaup (Ossem. Foss. Darmstadt, Plate xx., fig. 5). It appears to be imperfect, but consists of three transverse ridges and a talon; the longitudinal groove separates each ridge into two large rounded mammillæ; and there are only slight intermediate tubercles in the transverse valleys. The length of the specimen is about 115 mm., width 60 mm., height of crown 52 mm.

Mastodon longirostris has been found in Britain in the Red Crag of Suffolk and the Coralline Crag of Sutton; that is in the Nodule-bed which occurs under the Red and Coralline Crags. Prof. Lankester's specimen has the matrix of the so-called "Box stones" adhering to it. On the continent the species seems most abundant at Eppelsheim in beds of Upper Miocene or Lower Pliocene age; it has also been found in Pliocene beds in the Vienna basin and in France.

MASTODON BORSONI, HAAS.

Certain Mastodon teeth from the English Crag were first referred to *M. Borsoni* by Prof. Lankester (Geol. Mag., Vol. VI., 1869, and Quart. Journ. Geol. Soc., Vol. XXVI, p. 507, 1870), but Mr. R. Lydekker (*ibid.*, Vol. XLII., p. 364, 1886, and Cat. Foss. Mamm. Brit. Mus., Part iv., p. 26, 1886) has decided that the larger specimen figured by Prof. Lankester (*loc. cit.*, Plate xxxvi., fig. 1) is an imperfect tooth, and being really a part of a tetralophodont form should be referred to *M. longirostris* (*see above*, p. 43).

Dr. Falconer (Pal. Mem., Vol. II., p. 71, 1868) speaking of a specimen of *M. Borsoni*, says, "These molars are at once distinguished, all of them, from the *Mastodon angustidens* specimens, by the ridges being transverse, elevated, and trenchant, without intermediate mammillæ interrupting the valleys, and by their general similitude to *Mast. Ohioticus*."

The two smaller forms figured by Prof. Lankester (*loc. cit.*, fig. 3 and 4) now in the Museum at Ipswich, one of which in the explanation of the plate is named *Mastodon tapiroides*, Mr. Lydekker retains as representing *M. Borsoni* in the English Red Crag (Nodule-bed), together with a specimen in the Museum of Practical Geology, and another in the British Museum.

M. Borsoni has been recorded from Upper Pliocene strata at several localities in the south of France, and from the Val d'Arno in Italy. Also from Lower Pliocene beds in Piedmont and Hungary.

Genus ELEPHAS, Linnæus.

Elephant remains have been found abundantly in the Forest-bed, where the genus is represented by teeth of *E. meridionalis* and *E. antiquus*, as well as many forms which seem to be intermediate between these species and *E. primigenius*. Mr. Gunn has proposed to give names to some of these, but it is thought better by most authorities to regard them merely as varieties of the species above mentioned. Teeth of Elephants are only occasionally met with in the English Crags, and there has been much uncertainty as to the true horizon from which they have been derived, as well as respecting the species to which they belonged.

Dr. Falconer (Pal. Mem., Vol. II., p. 130, 1868), recorded *E. meridionalis* from the Norwich Crag of Thorpe, but this determination was doubted by Dr. Leith Adams (Pal. Soc., 1881, p. 178), who says, the species in Britain is restricted to the Forest-bed. Dr. Falconer likewise mentions an example of *E. antiquus* from the Red Crag of Southwold, in the Museum of the Geological Society (No. 10,664). This I am convinced is not a Red Crag specimen, and Prof. Lankester and Mr. Gunn (Geol. Mag., Vol. VI., p. 47 and 143, 1869) have both come to the same conclusion. A second specimen, alluded to by Dr. Falconer as being in the Museum of the Geological Society, I have been unable to find.

Prof. Prestwich also (Quart. Journ. Geol. Soc., Vol. XXVII., p. 456, 1871) gives *E. meridionalis* from the Norwich Crag.

The specimen of *Elephas*, said by Dr. Falconer (Pal. Mem., Vol. II., p. 54), to be in the Museum of Practical Geology, from the Red Crag of Felixstow, cannot now be identified; but portions of another tooth from the Red Crag have more recently been acquired by this Museum.

The Rev. O. Fisher (Geol. Mag., Vol. V., p. 544, 1868) noticed a specimen of *E. meridionalis* from the Red Crag; but this was shown by Prof. Lankester and Mr. Gunn (Geol. Mag., Vol. VI., pp. 47, 142, 143, 190, and 237) to be *Mastodon*, and not *Elephas*, and to have been found in the beds below the Coralline Crag.

Although Prof. Lankester says (Geol. Mag., Vol. V., p. 257, 1868), "No Elephant occurs with the Mastodon in the Suffolk bone bed, Dr. Falconer was, I believe, misled on this point by specimens from the Red Sands above the Red Crag," yet I think we now have indubitable evidence that *Elephas* does occur in the Red Crag, or in the "Bone bed" (Nodule-bed) below the Red Crag.

The specimen from the Red Crag of Trimley, Suffolk (some portions of which are in the Museum of Practical Geology, and others at York), referred by Dr. L. Adams doubtfully to *E. antiquus*, but now thought to be *E. meridionalis*, there can be no question is a Red Crag Fossil, or probably from the Nodule-bed below the Red Crag.

Dr. J. E. Taylor (Brit. Assoc. Rep. for 1873, p. 91, 1874 and "Bradford Observer," Sept. 22, 1873) gave an account of the

Elephant remains which were said to have been found in the Red Crag, and called special attention to one from Falkenham, which "he had not the slightest doubt" was really from the "Bone-bed" below the Red Crag; and he was probably correct in referring this specimen to *E. meridionalis*.

ELEPHAS MERIDIONALIS, NESTI.

Dr. Falconer (in Lyell's *Antiquity of Man*, p. 217, 1863, and *Pal. Mem.*, Vol. II., p. 104, 1868) was the first to recognise *E. meridionalis* in England. The species being especially abundant in the Forest-bed (*Mem. Geol. Surv. Vert. Forest Bed*, p. 105, 1882). The teeth of *E. meridionalis* are characterised by the small height of the crown in proportion to their width, the large size of the enamel plates and their wide separation by broad cement spaces. The enamel itself is extremely thick, smooth, and almost free from crenulations.

To this species is now referred the tooth from the Red Crag, which Dr. Leith Adams doubtfully placed with *E. antiquus* (*Pal. Soc. Brit. Foss. Elephants*, p. 178, 1877-81) and sections of which are to be seen in the York Museum, the British Museum, and the Museum of Practical Geology (*Cat. Fos. Mamm. Brit. Mus.*, Part iv., p. 113, 1886). Dr. Taylor's specimen from the Red Crag of Falkenham (*Brit. Assoc. Rep. for 1873*, p. 91, 1874) is included with *E. meridionalis*; the plates are wide and far apart, while the enamel is comparatively smooth and thick, and the crown appears to have been low. The occurrence of teeth, which cannot be separated from those of *E. meridionalis*, has been recorded by the Rev. O. Fisher (*Quart. Journ. Geol. Soc.*, Vol. XLIV., p. 818, 1888) from Dewlish, Dorset; thus indicating the presence of Pliocene beds in Dorset.

I am very doubtful whether the tooth from the Norwich Crag of Thorpe, noticed by Dr. Leith Adams (*Pal. Soc.*, p. 196), or that in Mr. Fitch's collection from same horizon, alluded to by Mr. Prestwich (*Quart. Journ. Geol. Soc.*, Vol. XXVII., p. 456, 1871) should be referred to this species.

Elephas meridionalis occurs in England in the Forest-bed series of many localities, in the Nodule-bed of the Red Crag of Suffolk, in the remarkable deposit at Dewlish, Dorset, and possibly in the Norwich Crag of Norfolk. On the continent the species is found in the Pliocene of the Val d'Arno, the Auvergne, and at Saint Prest; it has also been recorded from North Africa (*Thomas, Mem. Soc. Géol. Fr.*, Ser. 3, Vol. III., Part ii., p. 20, 1884).

Some vertebræ dredged off Clacton, and possibly of Pleistocene age, have been referred to this species by Dr. Leith Adams (*Pal. Soc.*, p. 210).

ELEPHAS ANTIQUUS, FALCONER.

The name *Elephas antiquus* was used by Falconer in 1857 (Quart. Journ. Geol. Soc., Vol. XIII., table facing p. 319) and the species he afterwards more fully defined (Pal. Mem., Vol. II.), but we are indebted to Dr. Leith Adams for a very complete history of this and other British species of *Elephas* (Pal. Soc., 1877-81).

Many of the Elephant teeth found in the "Forest Bed" belong to *E. antiquus* (Mem. Geol. Surv., Vert. Forest Bed, p. 104, 1882). Five examples were noticed by Leith Adams from the Norwich Crag, two from Southwold (Pal. Soc. 1877, pp. 17 and 38; (Cat. Foss. Mam. Brit. Mus., Part iv., p. 135, No. 39,463, 1886), two others from Eastern Suffolk, also in the British Museum (*loc. cit.* p. 124), and one from the same horizon at Horstead, in Mr. Gunn's collection, Norwich Museum.

In Mr. Colman's museum, Cliff House, Lowestoft, there are several portions of one or more teeth, collected by Mr. Randall Johnson from the Norwich Crag of Horstead, which have very broad and widely separated plates of thick enamel; the latter being strongly crenulated and with a median lozenge. This is one of the forms now called the broad plated variety of *E. antiquus*; the widely separated plates resemble the teeth of *E. meridionalis*. As already stated, the specimens from the Red Crag which Dr. Leith Adams doubtfully named *E. antiquus* are now thought to be *E. meridionalis* (see p. 140, and Cat. Foss. Mamm. Brit. Mus., Part iv., p. 123, 1886).

Elephas antiquus is not certainly known in England from beds older than the Norwich Crag; it is abundant in the Forest-bed, also in Cave-earth and other Pleistocene deposits.

The species seems to occur in Pliocene strata in Northern Italy (L. Adams, Pal. Soc., p. 5), but it is not included by Dr. Forsyth Major among the mammals of the Val d'Arno (Quart. Journ. Geol. Soc., Vol. XLI., p. 5, 1885). In Pleistocene deposits, however, it has been found in France, Italy, Spain, and probably North Africa (Cat. Foss. Mamm. Brit. Mus., Part iv., p. 123, 126, 127).

ELEPHAS PRIMIGENIUS ? BLUMENBACH.

It is very doubtful whether this species has ever been met with in Pliocene strata. The only Pliocene horizon which has yielded specimens which could possibly be referred to *E. primigenius* is the Forest-bed, and the teeth which have been found do not supply such undoubted proof of the occurrence of this species as could be desired. Although some of them approach the *E. primigenius* type of tooth, none are precisely like any undoubted example of the species, and the utmost that can be said is that some of the Forest-bed specimens may be extreme forms of *E. primigenius* (see Vert. Forest Bed, p. 106).

SIRENIA.

Genus HALITHERIUM, Kaup.

HALITHERIUM CANHAMII, FLOWER.

PLATE VI., FIG. 5.

Prof. Flower (Quart. Journ. Geol. Soc., Vol. XXX., p. 1, 1874) identified a portion of a skull from the Red Crag (Nodule-bed) of Foxhall, in the collection of the Rev. H. Canham, as that of a Sirenian, and described it as a new species of *Halitherium* to which he gave the name of *H. Canhami*. The specimen is now in the Ipswich Museum, but casts of it are to be seen in the British Museum and the Museum of Practical Geology. In the latter museum there are two or three pieces of ribs from the Red Crag Nodule-bed of Felixstow, and in the York Museum a cheek tooth and a piece of rib from the same bed, which are in all probability referable to this species.

RODENTIA.

Genus SCIURUS, Linnæus.

SCIURUS VULGARIS? LINNÆUS.

(Squirrel.)

(Vert. Forest Bed, p. 92, PLATE XIV., FIG. 12.)

The evidence for the occurrence of the squirrel in the Forest-bed rests partly on the gnawed fir-cones which are frequently found in this bed, and partly on the humerus of *S. vulgaris* found at Ostend, near Bacton, probably in the Forest-bed.

Genus CASTOR, Linnæus.

CASTOR FIBER, LINNÆUS.

(=CASTOR EUROPÆUS, OWEN.)

(Beaver.)

PLATE V., FIG. 16a, b.

(Also Vert. Forest Bed, PLATE XII.)

The remains of Beavers were said by Sir R. Owen (Brit. Foss. Mamm., p. 190, 1846) to have been found in the Norfolk Forest-bed and also in the Norwich (Fluvio-marine) Crag of Norfolk. The occurrence in the Forest-bed has been confirmed by the finding of additional examples (Mem. Geol. Surv. Vert. Forest Bed, p. 78, 1882). Two specimens were alluded to by Sir R. Owen as coming from the Norwich Crag, one of these, a femur from Thorpe, is in the British Museum, and is now, no doubt correctly, named *Trogontherium* (Cat. Foss. Mamm. Brit. Mus., Part i., p. 217, No. 40,979, 1885).

The second specimen (Plate V., fig. 18a, b, c) is thus referred to (*loc. cit.*, p. 192): "A portion of an incisor of the under jaw of a Beaver, now in the Museum of the Geological Society of London, was found by the President, H. Warburton, Esq., M.P., in the fluvio-marine Crag at Sizewell Gap, near Southwold," in Suffolk. This specimen, I find, has the enamel rounded and rough, not flattened and smooth as in *Castor fiber*. I should therefore refer it rather to *Trogontherium* than to *Castor*, and possibly it may belong to the small species which I have described below as *T. minus*.

Other notices of the occurrence of the common Beaver in the Crag are apparently based on the above specimens.

In the Museum of Practical Geology there are two cheek teeth of a Beaver from the Red Crag Nodule-bed; one of these, from Woodbridge, is a portion of a right upper premolar, about half an inch long, which has all three of the external enamel folds co-extensive with the tooth so far as this is preserved. The second tooth (Plate V., fig. 16a, b) is from Boyton, and is a left lower premolar, much worn, and forming fangs at its base; the three inner enamel folds extend nearly to the fang, and in this particular agree closely with a specimen of *Castor fiber* from the peat of Essex; the entire tooth, however, is smaller than the corresponding tooth of the Essex specimen. Provisionally the two Red Crag teeth are referred to *Castor fiber*.

The specific identity of *Castor europaeus* and *C. fiber* being generally admitted, the latter and earlier name is now used.

Castor fiber occurs in the Forest-bed and Red Crag Nodule-bed in East Anglia; it is also known in Pleistocene deposits both in England and on the continent, and is now living throughout the northern parts of the northern hemisphere. Gervais (Pal. Franç., Edit. 2, p. [20]) would unite with this the *Castor issiodorensis*, C. & J., from the Pliocene of Mont Perrier.

CASTOR VETERIOR, LANKESTER.

PLATE V., FIGS. 13, 14, 15.

Two upper cheek teeth and an incisor of a Beaver from the Red Crag of Sutton, in the Whinckopp collection (now in the Reed Collection, York Museum) were described by Prof. Lankester (Ann. Mag. Nat. Hist., Ser. 3, Vol. XIV., p. 355, 1864) as *Castor veterior*. The cheek teeth (see Plate V., figs. 14, a, b, c) are both left upper premolars, and were said to resemble those of the Canadian rather than those of the European form, differing chiefly "in the great length of the fang; the greater width of the fossæ of dentine between the enamel ridges, and in the greater inward development of the large anterior [inner] fold or lobe." Having made comparison with Beavers from the Fens, I can corroborate what Prof. Lankester says; but the variations observable in different specimens of *Castor fiber* would have made me doubt the validity of this new species, were it not for another point of difference which seems of greater importance, and it is that two of the three outer folds of enamel are only open to the exterior for a short distance from the summit of the tooth; while in *C. fiber* these folds are seen upon the exterior nearly to the base of the tooth.

The incisor tooth (Plate V., fig. 15, a, b), described by Prof. Lankester, has all the characters of an upper incisor of Beaver, and may very well be associated with the two cheek teeth.

Mr. E. C. Moor, of Great Bealings, has a fine upper premolar from the Red Crag of Newbourn, and there are two cheek teeth in the Canham collection, Ipswich Museum. *Castor veterior* is only known from the Red Crag Nodule-bed of Suffolk.

Genus **TROGONOTHERIUM**, Fischer.

TROGONOTHERIUM CUVIERI, CUVIER (FISCHER, MS.).

(Vert. Forest Bed, PLATE XI.).

The specimen on which this genus was established by M. Gothelf Fischer (Mem. Soc. Imp. Nat. Moscow, Vol. II., p. 260, 1809) was found in a sandy deposit near Taganrok, on the borders of the Sea of Azof. When *Trogontherium* was described no specific name was given to it, and after a prolonged search I have been unable to find that Fischer ever used the specific name of *T. Cuvieri*, although Cuvier attributes the name to him (Ossem. Foss., Nouvelle edit., 1823, Vol. V., p. 59), giving as a heading to Article III., "Des Castors des terrains meubles, et notamment de la grande espèce nommée *Trogontherium Cuvieri*, par M. de Fischer." Notwithstanding this heading, Cuvier called this rodent *Castor trogontherium*.

The presence of *Trogontherium Cuvieri* in the Forest-bed of Norfolk was first noticed by Sir R. Owen (Brit. Foss. Mamm., p. 184, 1846), and its intricate synonymy is given in the Survey Memoir (Vert. Forest Bed, p. 65, 1882), together with an account of the osteology, as far as known, and of the peculiar variations undergone by the patterns of the teeth during wear; which variations had led to the British specimens being referred to a distinct genus and species. A skull of this rodent, lately obtained by Mr. A. Savin from the Forest-bed of East Runton, still further confirms Sir R. Owen's opinion of the specific identity of these British specimens, and the *Trogontherium Cuvieri* of Fischer.

In Britain *T. Cuvieri* is essentially a Forest-bed species, most of the specimens being from that horizon; but fragments have been found in the Weybourn Crag at E. Runton and in the Norwich Crag of Thorpe. On the Continent it is known from the Pliocene of Saint Prest, under the name of *Conodontes Boisvilletii*.

TROGONOTHERIUM MINUS, NEWTON.

PLATE V., FIG. 17a, b, 18a, b, c.

A small *Trogontherium* maxilla from the Nodule-bed of the Red Crag of Felixstow,* in the possession of Mr. E. C. Moor, has received the name of *T. minus* (Quart. Journ. Geol. Soc.,

* Not from near Woodbridge as stated in original description.

Vol. XLVI., p. 447). The patterns of the three teeth which are preserved agree with those of *Trogontherium*, the folds of enamel being open exteriorly for only a short distance from the summit of the tooth, indeed, the three outer folds of each tooth have become shut off from the outside, and the single inner folds are very nearly in the same condition. The largest of these teeth (p.m. 4) which is closing in to form the fang, is 18 mm. long, and 8 mm. wide. The much smaller size of this specimen as well as its occurrence at a lower horizon has led to its receiving the distinctive specific name of *T. minus*. The tooth from the Norwich Crag of Sizewell Gap, near Southwold, noticed by Sir R. Owen as Beaver (Brit. Foss. Mamm., p. 192, 1846), and preserved in the Museum of the Geological Society, is provisionally included in this species.

Genus **MUS**, Linnæus.

MUS SYLVATICUS, LINNÆUS.

(*Field Mouse.*)

(Vert. Forest Bed, p. 93, PLATE XIV., FIGS. 11, 11a.)

Jaws and limb bones of *Mus sylvaticus* have been found in the Forest-bed at West Runton, and the species is now living throughout Europe.

Genus **MICROTUS**, Schrank (**ARVICOLA**, Lacépède).

MICROTUS (ARVICOLA) AMPHIBIUS ? LINNÆUS.

Water Vole.

It is very doubtful whether *A. amphibius* occurs in beds of Pliocene age. The form alluded to by Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 212, 1872) from the Norwich Crag is no doubt *Arvicola intermedius* (Mem. Geol. Surv., Vert. Forest Bed, p. 83, 1882), the only specimens I have seen from that horizon being referable to that species. Most of the *Arvicola* remains which occur in the Forest-bed are likewise *A. intermedius*, but possibly some of the larger teeth may be *A. amphibius* (Vert. Forest Bed, p. 87).

This species is found in Pleistocene deposits; it is now living throughout Europe and possibly in China.

MICROTUS (ARVICOLA) ARVALIS, PALLAS.

(Vert. Forest Bed, p. 88, PLATE XIV., FIGS. 2-5 and 7.)

Teeth and bones agreeing with those of *Arvicola arvalis* have been found in the Forest-bed at West Runton. Although the species is extinct in Britain it is still living on the continent.

A variety of *A. arvalis* is represented in the Forest-bed by certain teeth which approach those of *A. nivalis*, Martin.

Possibly the forms named *Arvicola campestris* by Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 212, 1872) in their list of Upper Crag Mammals may have belonged to the present species; but I have been unable to get any clue to the specimens, and the only remains of *Arvicola* I have seen from the Norwich Crag belong to *Arvicola intermedius*.

The species has also been found in the Pleistocene, and is now living on the continent of Europe.

MICROTUS (ARVICOLA) GREGALIS, PALLAS.

(Vert. Forest Bed, p. 90, PLATE XIV., FIGS. 6, 6a.)

Teeth which are believed to belong to this species have been found in the Forest-bed at West Runton. At the present day *A. gregalis* is an inhabitant of Eastern Siberia.

MICROTUS (ARVICOLA) GLAREOLUS, SCHREBER.

(*Bank Vole.*)

(Vert. Forest Bed, p. 82, PLATE XIV., FIGS. 1-1c.)

This species is first given as occurring in the Forest-bed by Messrs. Blackmore and Alston (Proc. Zool. Soc., 1874, p. 461). It is doubtful whether the specimens so named, which are in the Norwich Museum, really belong to *A. glareolus*, but fortunately an undoubted example has been found in the Forest-bed at West Runton.

The species occurs in Pleistocene deposits, and is now living throughout Europe north of the Apennines and east of the Ural Mountains.

MICROTUS (ARVICOLA) INTERMEDIUS, NEWTON.

(Vert. Forest Bed, p. 83, PLATE XIII., FIGS. 1-13.)

This species was founded for the reception of numerous specimens of *Arvicola* from the Forest-bed and Norwich Crag. (Mem. Geol. Surv., Vert. Forest Bed, p. 83, 1882) which differed from *A. amphibius* in having well developed fangs to the cheek teeth, and in being of a somewhat smaller size. It is no doubt the form alluded to by Sir R. Owen (Brit. Foss. Mamm., p. 205) as intermediate in size between the Water-vole and Field-vole. At present the species is only known with certainty from the Forest-bed of Norfolk and Suffolk, and from the Norwich Crag of several localities in Norfolk, but an *Arvicola* with fanged teeth

has been noticed in the Lignites of Lombardy by Dr. Forsyth Major (Att. Soc. Ital. Sci. Nat., Vol. XV., p. 389, 1872).

Genus LEPUS, Linnæus.

Lepus cuniculus is included by Messrs. R. and A. Bell in their list of Upper Crag Mammals (Proc. Geol. Assoc., Vol. II., p. 212), but I have been unable to verify their record.

The Museum of Practical Geology has recently acquired, through Mr. T. Jesson, a portion of an incisor tooth, from the Red Crag of Butley, which agrees very closely with the lower incisor of the rabbit; but the hinder part of this tooth, which is not protected by enamel, is not so thick. The lesser thickness of the fossil tooth may be due to partial denuding, but, even if allowance be made for this, the evidence is not sufficient to justify a specific determination. The genus, however, may be recorded.

RODENT; GENUS UNDETERMINED.

PLATE V., FIGS. 19a, b.

Mr. James Reeve, the Curator of the Norwich Museum, obtained, from the Norwich Crag of Bramerton, a small cheek tooth of a Rodent presenting peculiarities unlike any tooth with which I am acquainted. The specimen was found inside a univalve shell, so that it is quite certain that it belonged to the Crag, and had not been introduced at a later period. This tooth is about 14 mm. in length and 3 mm. in width, and being the same size from top to bottom, and without any sign of fangs, no doubt had a persistent pulp. In section the tooth is triangular or rather heart-shaped. On one side there are two grooves running the length of the tooth, and between these a fold of enamel extending half way across the tooth.

INSECTIVORA.

Genus TALPA, Linnæus.

TALPA EUROPEA, LINNÆUS.

(Mole.)

(Vert. Forest Bed, p. 95, PLATE XV., FIGS. 1-4.)

The remains of the Mole have long been known to occur in the Forest-bed, but it has not been recorded from any other Pliocene formation in Britain. The species occurs in Caves (Owen, Brit. Foss. Mamm., p. 19, 1846), but it is a little doubtful whether it is of Pleistocene age; it is now living in the northern and temperate parts of Europe, although apparently absent from Ireland and the north of Scotland; it ranges also into Siberia as far as the River Lena.

Genus SOREX, Linnæus.

SOREX VULGARIS, LINNÆUS.

(Shrew.)

(Vert. Forest Bed, p. 97, PLATE XV., FIGS. 5-10.)

Several mandibular rami and limb bones of *Sorex vulgaris* have been found in the Forest-bed, and probably the specimen figured by Sir R. Owen (Brit. Foss. Mamm., p. 28, fig. 14, No. 3), and called *Sorex remifer*, belongs to this species. *S. vulgaris* has been recorded from Cave deposits, and is now living throughout middle Europe.

SOREX PYGMÆUS, PALLAS.

(Pigmy Shrew.)

(Vert. Forest Bed, p. 97, PLATE XV., FIGS. 11, 12.)

Some small mandibular rami and limb bones from the Forest-bed are believed to belong to *Sorex pygmæus* as well as the specimen figured by Sir R. Owen as *S. fodiens* (Brit. Foss. Mamm., p. 28, fig. 14, No. 1).

This species is now living throughout Europe and North Asia, and is said to occur in North Africa.

Genus MYOGALE, Cuvier.

MYOGALE MOSCHATA, LINNÆUS.

(Vert. Forest Bed, p. 98, PLATE XVI., FIGS. 1-10.)

Sir Richard Owen in the year 1846 (Brit. Foss. Mamm., p. 46) described the jaw of a peculiar Insectivore from the Forest-bed of Ostend, near Bacton, and named it *Palaeospalax magnus*; but M. Lartet in 1863 (Compt. Rend., p. 1201) was convinced of its specific identity with the Russian Desman (*Myogale moschata*), a determination which has been confirmed by subsequent observation.

Numerous specimens have since been found, including upper and lower jaws with teeth, as well as limb-bones, which were described in the Forest-bed Memoir, and on comparison were found to agree precisely with the corresponding bones of the recent *M. moschata*, a skeleton of which is fortunately preserved in the Royal College of Surgeons.

The cheek-teeth of the living *M. moschata* are sharp pointed and numerous, there being 10 in the upper jaw and nine in the lower, on each side. The three true molars of both upper and lower jaws have a double V-shaped pattern. In the upper jaw, immediately in front of the molars, is a tooth smaller than the molars, but larger and more complex than the simple crowned teeth placed anterior to it, the first four of which are subequal and of moderate size, while the two anterior ones are much smaller. In the lower jaw there are six simple crowned teeth, the three anterior ones being much smaller than the others. The humerus has a peculiar form, but it is not so aberrant as that of the mole.

At the present day *Myogale* is represented by two species, *M. moschata* and *M. pyrenaica*, both of which have a restricted distribution; the former being found only in the district between the rivers Don and Volga, in Russia; while the latter, and smaller species, is living in the Pyrenees.

Myogale moschata has only been found fossil in the Forest-bed of Bacton, West Runton, and Beeston, near Cromer.

CETACEA.

As early as the year 1843 Sir R. Owen (Proc. Geol. Soc., Vol. IV., p. 283, and Quart. Journ. Geol. Soc., Vol. I., p. 39, 1845) described some Cetacean remains from the Suffolk Crag as "Fossil Tympanic bones referable to four distinct species of *Balaena*." These specimens were afterwards more fully described and illustrated (Brit. Foss. Mamm., p. 526, 1846), and some large teeth, also from the Suffolk Crag, were named *Balaenodon physaloides*. Until quite recently the names given to these Cetacean remains have been almost universally adopted.

Prof. Lankester in 1864 (Annals, Ser. 3, Vol. XIV., p. 356) gave an account of some Cetacean specimens from the Red Crag which had come under his notice and referred them to *Delphinus*.

A ziphoid rostrum from the Red Crag was described by Prof. Huxley in 1864 (Quart. Journ. Geol. Soc., Vol. XX., p. 388), and several species of them were named by Sir R. Owen (Pal. Soc. 1870), and by Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXVI., p. 502, 1870). More recently Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 7, 1887, and Cat. Foss. Mamm. Brit. Mus., Part v., p. 16, 1887), has revised the nomenclature of the Crag Cetacea, adding several forms not previously recognized, and the following notes on the species are for the most part in accordance with Mr. Lydekker's determinations.

Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 338, 1871) has recorded the finding of the Vertebræ of a whale 31 feet long in a brick pit at Chillesford; but the specimen was never properly identified and has, I believe, been since destroyed. Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 215, 1872) notice this specimen as well as another from the Norwich Crag, calling them both *Balaena*.

Cetacean remains referable to several species have also been found in the Forest-bed (Mem. Geol. Surv., Vert. Forest Bed, p. 108, 1882; Quart. Journ. Geol. Soc., Vol. XLII., p. 316; and Geol. Mag., Dec. 3, Vol. VI., p. 145, 1889).

BALÆNIDÆ.

Genus BALÆNA, Linnæus.

BALÆNA BISCAYENSIS, GRAY.

PLATE VI., FIG. 1.

The ankylosed cervical vertebræ of a large whale from the Forest-bed near Cromer, in the Backhouse Collection at York,

has been referred to the above species (Newton, Quart. Journ. Geol. Soc., Vol. XLII., p. 319, Pl. xi, fig. 5, 1886).

The somewhat similar specimen from the Pliocene of Chiusi near Pisa, named *Balaena etrusca* by Prof. Capellini (Mem. Acc. Sci. Inst. Bologna, Ser. 3, Vol. III., 1873) has really a different form and the arrangement of the neural arches is not the same.

Mr. A. Savin has obtained a large Cetacean tympanic bone, from the Forest-bed at East Runton, which resembles that of *B. balænopsis* figured by Prof. Van Beneden (Ann. Mus. Roy. Hist. Nat. Belg., Vol. IV., Part ii, Pl. 3, 1880), but is larger; it also resembles some of the forms referred to *B. insignis* and *B. primigenia*; but as the tympanics of these species are so much alike, and evidently closely allied to the recent *B. biscayensis*, and as this is the only species at present known in the Forest-bed, the East Runton specimen is provisionally placed in the latter species.

Balaena biscayensis was formerly abundant on the western coasts of Europe, but appears now to be nearly extinct.

BALÆNA AFFINIS, OWEN.

PLATE VI., FIG. 3.

This is one of the four species proposed by Sir R. Owen (Proc. Geol. Soc., Vol. IV., p. 283, 1843, and Quart. Journ. Geol. Soc., Vol. I., p. 39, also Brit. Foss. Mamm., p. 530, 1846) for the tympanic bones known to him from the Suffolk Crag, and were placed in the genus *Balaena*; but subsequently altered to *Balaenodon* (Brit. Foss. Mamm., table opposite p. xlvi, and Palæontology, 1860, p. 342). Mr. Lydekker thinks this species should be retained in the genus *Balaena* (Quart. Journ. Geol. Soc., Vol. XLIII., p. 8, 1887) and says: "The tympanic of *B. affinis* is characterized by its elongated shape and flat anterior surface, its nearly straight inferior border, which is approximately parallel with the superior border of the inner wall, the height of the inner wall at the Eustachian part of the aperture, the produced antero-inferior angle, and the slight thickening of the involucrum." Specimens of this species are to be seen in the British Museum, Museum of Practical Geology, and elsewhere. *Balaena affinis* is only known in England from the Nodule-bed of the Red Crag of Suffolk; but specimens precisely similar have been found in the Antwerp Crag and are in the Brussels Museum.

BALÆNA PRIMIGENIA, V. BENEDEN.

PLATE VI., FIGS. 2a, 2b.

This species was established by Prof. Van Beneden (Bull. Acad. Roy. Belg., Vol. XXXIV., p. 9, 1872, and Ann. Mus. Hist. Nat., Vol. IV., Part 2, p. 66, 1880), for certain large Cetacean bones

from the Antwerp Crag, including examples of the tympanics, and some English Red Crag specimens have been identified as belonging to this species by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 8, 1887). The tympanic of *Balæna primigenia* is said to agree with that of *B. biscayensis* and *B. australis* in the convexity of the inferior border, in the absence of a produced antero-inferior angle and in the comparative lowness of the Eustachian portion of the aperture. Mr. Lydekker recognises much variation in the forms referred to this species, and that which he regards as typical has "the inner wall very high, its superior border oblique, the flattening of the exterior surface extending nearly or quite down to the border, the involucrum considerably thickened, and the inferior border somewhat angulated."

In a second variety "the obliquity of the superior border of the inner wall is excessively developed."

A third variety "is distinguished by its extreme lateral compression and the total absence of any thickening of the involucrum."

And a fourth variety "is characterised by the lowness of the inner wall, the parallelism of its superior border to the long axis of the bone, the slight downward extent of the flattening of the anterior surface, and the absence of any distinct angulation of the inferior border."

Examples of this species are to be seen in most collections of Red Crag Fossils.

Balæna primigenia is only known in the Red Crag Nodule-bed of Suffolk and in the Antwerp Crag (Scaldonian).

BALÆNA (BALÆNOTUS) INSIGNIS, V. BENEDENI.

PLATE VI., FIGS. 4a, b.

The genera *Balænotus* and *Balænula* of Van Beneden (Bull. Acad. Roy. Belg., Ser. 2, Vol. XXXIV., p. 13, 1872, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. IV., Part 2, p. 71, 1880) are included by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 11, 1887) in the genus *Balæna*.

Balæna insignis tympanic bones are said to be very much like those of the fourth variety of *B. primigenia* but are "usually "more inflated, thicker inferiorly and with a distinct angulation "of the inferior border."

The tympanics of *B. insignis* and *B. balænopsis* are so similar that Mr. Lydekker could only make a separation by referring the larger ones to the former species, and the smaller ones to the latter.

Several tympanic bones in the British Museum from the Nodule-bed of the Red Crag of Suffolk are referred to the present species, which is only known from this horizon and from the Antwerp Crag.

BALÆNA (BALÆNULA) BALÆNOPSIS, V. BENEDEEN.

PLATE VI., FIGS. 5a, b.

The tympanic bones of this species are said to be very similar to those of the last, but smaller. *Balæna balænopsis* was described by Prof. Van Beneden (Bull. Acad. Roy. Belg., Ser. 2, Vol. XXXIV., p. 11, 1872, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. IV., Part 2, p. 52, 1880), from specimens found in the Antwerp Crag, and Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 10, 1887) has identified tympanes of the same form in the British Museum from the Nodule-bed of the Red Crag of Suffolk, while an atlas vertebra from the true Coralline Crag of Sudbourn, Suffolk, also in the British Museum (No. M. 3,542), has been referred to this species by Prof. Van Beneden.

Genus MEGAPTERA, Gray.

MEAPTERA AFFINIS, V. BENEDEEN.

PLATE VI., FIGS. 6a, b.

The bones from the Antwerp Crag named *M. affinis* by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. L., p. 13, 1880, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part. 3, p. 39, 1882), were previously called by the same writer *Megapteropsis robusta* (Bull. Ac. R. Belg., Ser. 2, Vol. XXXIV., p. 15, 1872).

Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 11, 1887) provisionally refers to this species a right tympanic from the true Coralline Crag of Sudbourn, preserved in the Museum of Practical Geology, which is characterised by its inflated form, pear-shaped involucrum, and blunted anterior extremity.

Another specimen in the Museum of Practical Geology from the Nodule-bed of the Red Crag, near Ipswich, is also referred to this species.

MEAPTERA (BURTINOPSIS) SIMILIS, V. BENEDEEN.

The genus *Burtinopsis* of Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXIV., p. 19, 1872; also Vol. L., p. 16, 1880, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 77, 1882) is disallowed by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 11, 1887), who includes the forms so named under the genus *Megaptera* and with some doubt refers to the species *M. similis* a left periotic from the Nodule-bed of the Red Crag of Woodbridge, in the British Museum (No. 39,020); and it appears from his remarks that the three forms of *Megaptera* tympanes which he has found in the English Crags are distinguished chiefly by their difference of size, the forms being nearly identical. The Antwerp Crag and the Nodule-bed of the Red Crag of Suffolk are the only places from which this species has been obtained.

MEGAPTERA (BURTINOPSIS) MINUTA, V. BENEDEEN.

PLATE VI., FIGS. 7a, b.

Megaptera minuta, was described by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. L., p. 17, 1880, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII, Part 3, p. 80, 1882) from specimens found in the Antwerp Crag. This, which is the smallest of the three species of *Megaptera* found in the Crag, is represented in the true Coralline Crag of Suffolk by a nearly perfect tympanic bone in the Ipswich Museum, and in the Nodule-bed of the Red Crag of Foxhall by a rolled specimen in the Museum of Practical Geology.

Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 11, 1887) says: "Except by its smaller size, the English specimen [from Coralline Crag] can scarcely be distinguished from the tympanics of the existing *M. boops*."

Genus BALÆNOPTERA, Lacépède.

BALÆNOPTERA DEFINITA, OWEN.

PLATE VI., FIGS. 8a, b.

This is one of the four species founded by Sir R. Owen (Proc. Geol. Soc., Vol. IV., p. 283, 1843; Quart. Journ. Geol. Soc., Vol. I., p. 39, 1845, and Brit. Foss. Mamm., p. 531, 1846) for Crag tympanic bones. The original specimens being imperfect it has always been troublesome to know what should be referred to these species, but with regard to the one under consideration, Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 11, 1887) says there is a fairly perfect tympanic in the Ipswich Museum which "agrees exactly with the imperfect type tympanic (of which a cast is preserved in the Museum of the College of Surgeons); and as it differs from the corresponding bone of *B. Goropi* by its larger size, its greater inflection, greater height of the inner wall, smaller depth of the Eustachian notch, sharper posterior angle, and more gibbous involucrum, there is little doubt of its specific distinctness, and every probability of its being identical with the so-called *B. Sibbaldina*, V. Ben. [Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 63, 1880] of which the tympanic has been hitherto unknown. This is confirmed by a very fine late cervical vertebra from the Red Crag in the Ipswich Museum, which corresponds exactly with the type specimen of the latter form in the Brussels Museum."

If Mr. Lydekker is correct in referring *B. sibbaldina* to this species, then *B. definita*, Owen, occurs in the Nodule-bed of the Red Crag of Suffolk and in the Antwerp Crag.

BALÆNOPTERA (PLESIOCETUS) GOROPI, V. BENEDEN.

To this species, which is said to be rather smaller than the last, Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII, p. 12, 1887) refers an imperfect tympanic, from the Red Crag Nodule-bed of Suffolk, in the British Museum (No. 39,016) and possibly some vertebrae in the same collection.

Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXIV., p. 15, 1872) described a large part of a skeleton from the Antwerp Crag under the name of *Plesiocetus Goropii*, but afterwards (*ibid.*, Vol. L., p. 15, 1880) and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 65, 1882) altered it to *Balænoptera musculoides*, and noticed specimens described by Prof. Capellini, from the Pliocene Beds of Pizzo in Italy.

BALÆNOPTERA BOREALINA, V. BENEDEN.

This species, which is said to be of smaller size than *B. Goropi*, was described by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. L., p. 15, 1880, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 71, 1882) from specimens obtained from the Antwerp Crag, and Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887) has recognised tympanics of the same species, from the Red Crag Nodule-bed of Suffolk, in the Ipswich Museum and in the British Museum (Cat. Foss. Mamm., Part v., p. 39, 1887).

BALÆNOPTERA EMARGINATA, OWEN.

PLATE VI., FIGS. 9a, b.

The tympanics from the Red Crag, which Sir R. Owen (Proc. Geol. Soc., Vol. IV., p. 283, 1843.—Quart. Journ. Geol. Soc., Vol. I., p. 40, 1845.—Brit. Foss. Mamm., p. 533, 1846) named *Balaena emarginata* and *B. gibbosa*, Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887, and Cat. Foss. Mamm. Brit. Mus., Part v., p. 40, 1887) now refers to the genus *Balænoptera* and unites in one species *B. emarginata*; and at the same time expresses the opinion that the tympanics of *B. rostratella* from the Antwerp Crag described by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2., Vol. L., p. 16, 1880, and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 73, 1882) cannot be separated from *B. emarginata*, and that the latter name, being the earliest, must be used.

Several tympanics from the Nodule-bed of the Red Crag of Suffolk in the Museum of the Royal College of Surgeons (Nos. 2,822-25) and one in the British Museum (No. 39,016a) have been identified as this species by Mr. Lydekker and there are others in the Museum of Practical Geology. *Balænoptera*

emarginata may be said, therefore, to occur in the Nodule-bed of the Red Crag of Suffolk, and in the Antwerp Crag.

BALÆNOPTERA, sp.

A large vertebra from the Forest-bed near Cromer is referred to this genus (Mem. Geol. Surv., Vert. Forest Bed, p. 108, 1882, and Quart. Journ. Geol. Soc., Vol. XLII., p. 322, 1886) and indicates a form as large as a full-sized Fin Whale (*B. musculus*).

Genus CETOTHERIUM, Brandt.

CETOTHERIUM (PLESIOCETUS) BRIALMONTI, V. BENEDEN.

The genera *Plesiocetus* and *Heterocetus* of Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. L., pp. 18 and 21) are included by Mr. R. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887, and Cat. Foss. Mam. Brit. Mus., Part v, p. 42, 1887) in Brandt's *Cetotherium*. The tympanic bone of this genus is said by Mr. Lydekker to be "distinguished from that of *Balaenoptera* by its anteriorly pointed form, the triangular shape of the roughened inferior surface, and the less flattened involucrum."

To *Cetotherium Brialmonti* Mr. Lydekker refers an imperfect axis vertebra in the British Museum (No. 46,734) from the Red Crag of Suffolk. The species was originally described from specimens from the Antwerp Crag by Prof. Van Beneden (loc. cit. and Ann. Mus. Roy. Hist. Nat. Belg. Vol. IX., Part 4., p. 12, 1885).

CETOTHERIUM (PLESIOCETUS) DUBIUM, V. BENEDEN.

PLATE VI., FIGS. 10a, b.

This species, which is said to be smaller than *C. Brialmonti*, was described by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXIV., p. 18, 1872, Vol. L., p. 18, 1880, and Ann. Mus. Roy. Hist. Nat. Belg. Vol. IX., Part 4., p. 21, 1885) from specimens found in the Antwerp Crag, and Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887) refers to the same species two tympanics in the Museum of the Royal College of Surgeons (Nos. 2,852, A. and B.) from the Nodule-bed of the Red Crag of Suffolk and probably others in the British Museum and Museum of Practical Geology from the same horizon.

CETOThERIUM (PLESIOCETUS) HUPSCHI? V. BENEDEN.

Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887) has provisionally referred to this species some vertebræ in the British Museum (Cat. Foss. Mamm., Part v., p. 45, 1887), and also in the Museum of Practical Geology, from the Red Crag of Suffolk. The original specimens were from the Antwerp Crag and were described with the last species (*loc. cit.*) by Prof. Van Beneden, who mentions an axis vertebra from the Pliocene of Montpellier, the base of a cranium in the Cambridge Museum from between "Sautwald" [Southwold] and Covehythe (Suffolk) [? Norwich Crag] and a vertebra in the British Museum from the Pliocene (?) near Lisbon.

CETOThERIUM (HETEROCETUS) BREVIFRONS, V. BENEDEN.

Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 12, 1887) having examined the type specimens in the Brussels Museum refers to this small form three specimens from the Suffolk Red Crag, namely, an "axis vertebra in the British Museum and another in the Ipswich Museum, while it is not improbable that a small tympanic in the latter collection may also belong to this species." Prof. Van Beneden's types were from the Antwerp Crag and were placed in a separate genus *Heterocetus*.

Genus HERPETOCETUS, V. Beneden.

HERPETOCETUS SCALDIENSIS, V. BENEDEN.

PLATE VI., FIG. 11a, b.

The lower jaw of this genus having the angle produced and the articular surface on the upper part, there is some resemblance to a reptilian jaw, and hence the name proposed for it by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXIV., p. 20, 1872; Vol. L., p. 25, 1880; and Ann. Mus. Roy. Hist. Nat. Belg., Vol. VII., Part 3, p. 84, 1882). The tympanic bone is said by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 13, 1887) to be "readily recognised by its egg-like shape, the small and sharply defined involucrum, and the filling-up of the anterior portion of the cavity by osseous matter A tympanic from Red Crag [Felixstow] in the Museum of Practical Geology, indicates the occurrence of *Herpetocetus Scaldiensis*, Van Beneden, in this country and No. 2,816 in the Museum of the College of Surgeons is a second example."

The type specimens were from the Antwerp Crag and Prof. Van Beneden notices a specimen from Louvain. The British specimens are from the Red Crag Nodule-bed.

PHYSETERIDÆ.

Genus PHYSETER, Linnæus.

PHYSETER MACROCEPHALUS, LINNÆUS.

(Sperm Whale.)

PLATE VII., FIG. 1.

A large tooth, obtained by Mr. Clement Reid, from the Forest-bed of Sidestrand, near Cromer, and now in the Museum of Practical Geology, has been referred by the writer (Quart. Journ. Geol. Soc., Vol. XLII., p. 316, 1886,) to *Physeter macrocephalus*, a living species, which at the present day is found chiefly in tropical and warmer temperate latitudes; but occasionally wanders further north, and has been found stranded on the shores of Great Britain.

The Sperm Whale was said by Mr. Charlesworth (Proc. Geol. Soc., Vol. IV., p. 286, 1843, and Quart. Journ., Vol. I., p. 40, 1845) to occur in the Red Crag; but the tooth alluded to no doubt belonged to the form now known as *Eucetus*. Apparently on Mr. Charlesworth's authority Messrs. R. and A. Bell included this species in the Red Crag fauna.

Genus EU CETUS, Du Bus.

EU CETUS AMBLYODON, DU BUS.

PLATE VIII., FIGS. 1. 2. 3.

Some large Physeteroid teeth, 9 or 10 inches long, from the Antwerp Crag, were named *Eucetus amblyodon* by Du Bus (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXIV., p. 572, 1867), and they were further described and figured by Profs. Van Beneden and Gervais (Ostéographie des Cétacés, p. 344, Pl. XX., figs. 29, 30, 1880). These teeth, like a large number of those from the English Crag, have no enamelled crowns. Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 13, 1887) says this form "is represented in nearly all Crag collections by many teeth, which belong to the type species, *E. amblyodon*; the cement is of great thickness, the dentine-core fusiform, and the osteodentine nodular. I provisionally refer to this species a large left periotic in the British Museum, which in the partial production of its posterior extremity more nearly resembles the periotic of *Hyperoodon* than that of *Physeter*." I accept Mr. Lydekker's reference of these large teeth to Du Bus' *Eucetus amblyodon*, and I see no reason for objecting to the provisional reference of the periotic in the British Museum to the same species.

Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXI., p. 231, 1865) included these large teeth with, *Balaenodon physaloides*, Owen; but, for reasons given below, I am of opinion that Sir R. Owen's species is quite distinct.

It seems very probable that the teeth with enamel crowns, known as *Scaldicetus*, will eventually prove to be the same as those called *Eucetus*, the latter, it may be, having lost their crowns.

Eucetus amblyodon is now recognised from the Nodule-bed of the Red Crag of Suffolk and from the Antwerp Crag.

Genus BALÆNODON, Owen.

BALÆNODON PHYSALOIDES, OWEN.

PLATE VII., FIGS. 2a, b, 3a, b.

Sir R. Owen (Brit. Foss. Mamm. p. 536, 1846) described a portion of a large Physeteroid tooth from the Red Crag of Felixstow, which on account of the slender core of dentine and thick cement, he regarded as distinct from the recent Cachalot, and named *Balaenodon physaloides*. That the tooth thus named is distinct from that of the Cachalot is not doubted; but Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887) thinking that it was identical with *Scaldicetus Carreti*, Du Bus (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXIV., p. 568, 1867), questioned the correctness of the original description.

Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXI., p. 231, 1865) noticed the Crag teeth which had been very generally referred to *Balaenodon physaloides*, and called attention to the probability of the larger forms being closely related to the teeth found in the Antwerp Crag, which Prof. Van Beneden considered to belong to ziphoid forms of Cetacea, and which have since been named *Eucetus amblyodon* by Du Bus.

The type specimen of *Balaenodon physaloides* is preserved in the British Museum, and fresh microscopic sections having been prepared, Mr. Lydekker and I have carefully examined them and we are now able to confirm the description and figures given by Sir R. Owen (*loc. cit.*) The slender cylinder of dentine is remarkable, leading one to think when first examining the tooth, that the whole of the specimen was dentine, and Mr. Lydekker has expressed this opinion (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887) but an examination with a microscope shows that the thick outer coating is cement, as stated by Sir R. Owen, and resembles the cement of other Physeteroid teeth in having largely developed "Sharpey's Fibres" as well as closely set lacunæ. By the courtesy of M. Dupont of the Brussels Museum we have been able to compare microscopic sections of the tooth of *Scaldicetus Carreti*, and we are able to confirm Mr. Lydekker's statement (*loc. cit.*), that the dentine of this tooth is thick like that in *Eucetus*, and, therefore, as we now find, unlike the slender form which it has in *Balaenodon physaloides*, and *Scaldicetus* is regarded as distinct from *Balaenodon*, whatever may be its relationship to *Eucetus*.

There are three teeth from the Red Crag of Suffolk in the Museum of Practical Geology, which having been cut through

longitudinally show a slender core of dentine similar to that of the type of *Balaenodon physalooides*. One of these agrees in form also very closely with the type, and although about one third smaller can only be referred to that species.

The other two differ somewhat in shape, one being nearly cylindrical, much curved, measuring 110 mm. in length and 19 or 20 mm. in width, tapering only slightly at each end; while the third example is nearly straight, spindle-shaped, due to the great development of cement in the middle where the diameter is 34 mm. the length being 120 mm. In both these teeth the dentine is a little thicker at the upper part of the tooth than at the base; and in the smaller tooth, which has the thickest core of dentine, the greatest diameter of the dentine is 8.5 mm.

Bearing in mind the extreme variation in form among the teeth of the recent *Physeter macrocephalus* it is thought best to refer all three specimens to *Balaenodon physalooides*, which at present is only known from the Nodule-bed of the Red Crag of Suffolk.

Genus PHYSETERULA, V. Beneden.

PHYSETERULA DUBUSII? V. BENEDEN.

This genus and species was established by Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XLIV., p. 851, 1877) for a lower jaw from the Antwerp Crag, about 45 inches long containing numerous teeth, the largest of which were perhaps five inches in length. Mr. Lydekker provisionally refers to this species a tooth from the Red Crag (Nodule-bed) of Woodbridge, now in the British Museum (No. 49,966, Cat. Foss. Mamm., Part v, p. 54, 1887) which he had previously referred to *Homocetus Villersi* (Quart. Journ. Geol. Soc., Vol. XLIII. p. 14, 1887).

The great variety of forms which occur among the teeth of the recent Sperm Whales, and even among the teeth of one individual makes it highly probable that the Crag teeth, in which the development of cement was greater than in the living species, varied to as great if not to a greater extent, and consequently it is highly probable, as already suggested by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, p. 345, 1880) that many of the forms from the Antwerp Crag, which have been named as several distinct genera and species will eventually prove to belong to only a few species. Under these circumstances I should have hesitated before introducing some of these names into English literature; but as Mr. Lydekker has already done so, the present and five following species are provisionally and doubtfully accepted on his authority.

Genus **PHYSODON**, Gervais.

(PALÆODELPHIS, Du Bus.)

PHYSODON GRANDIS? *DU BUS.*

This name was proposed by M. Du Bus (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXIV. p. 503, 1872) for certain teeth from the Antwerp Crag, which were afterwards figured by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, p. 336, Pl. xx. f. 21, 1880).

Specimens from the Red Crag Nodule-bed of Suffolk have been referred to this species by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887, and Cat. Foss. Mamm. Brit. Mus., Part v, p. 59, 1887).

PHYSODON FUSIFORMIS? *DU BUS.*

This species like the last was named by M. Du Bus (*loc. cit.*) and figured by Profs. Van Beneden and Gervais (*loc. cit.*, Plate xx., f. 19, 20). To it Mr. Lydekker refers a tooth in the British Museum from the Red Crag Nodule-bed of Woodbridge (Cat. Foss. Mamm., p. 60, 1887).

Genus HOPLOCETUS, Gervais.**HOPLOCETUS CRASSIDENS?** *GERVAIS.*

Two teeth from the Faluns de Romans (Drôme) [Miocene] received the name of *H. crassidens* from M. Gervais (Zool. Pal. Fr. edit. 1, p. 161, Plate xx., figs. 10, 11, 1848-52), and Sir R. Owen (Quart. Journ. Geol. Soc., Vol. XII., p. 228, 1856) noticed teeth from the Red Crag of Suffolk "corresponding in size and form to the singular teeth" thus named. This form of tooth is, figured by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, Plate xx., f. 26, 27, 1880) and Mr. Lydekker is of opinion that certain teeth from the Red Crag Nodule-bed of Suffolk may be referred to the same species (Quart. Journ. Geol. Soc. Vol. XLIII., p. 14, 1887).

HOPLOCETUS BORGERHOUTENSIS? *DU BUS.*

This name was given by Du Bus (Bull. Ac. Roy. Belg., Ser. 3, Vol. XXXIV., p. 502, 1872) to a series of six teeth from the Belgian Crag; and a tooth is figured by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, Pl. xx., f. 28). Certain teeth from the

Red Crag Nodule-bed of Suffolk are placed in this species by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887).

HOPLOCETUS CURVIDENS? GERVVAIS.

A large tooth from the Marine Pliocene of Montpellier was named as above by Prof. Gervais. (Zool. Pal. Fr. edit. 1, p. 161, pl. 3, f. 12, 1848-52, and Ostéogr. Cétacés, p. 340, Pl. xx., f. 25, 1880). Mr. Lydekker doubtfully refers to the same species some teeth from the Red Crag Nodule-bed of Suffolk (Quart. Journ. Geol. Soc., Vol. XLVIII., p. 14, 1887).

Genus HYPEROODON, Lacépède.

PLATE VIII., FIG. 4.

The occurrence of this genus in the Suffolk Red Crag is thus noticed by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII. p. 14, pl. ii, fig. 6, 1887): " *Hyperoodon* is represented by a very perfect right periotic from the Red Crag in the Ipswich Museum. This specimen, which has the accessory ossicle still attached, cannot be distinguished from the corresponding bone of the existing *H. rostratus*, and evidently indicates the existence either of that or of a closely allied form in the Pliocene; the occurrence of cervical vertebræ of a member of this genus in the Antwerp Crag has been recorded by Prof. Van Beneden" (Bull. Ac. Roy. Belg., Ser. 2, Vol. X., p. 407, 1860).

Genus CHONEZIPIHIUS. Duvernoy.

This genus, which differs from *Mesoplodon* in the non-ossification of the supra vomerine (or mesethmoid) cartilage, is represented in the Suffolk Crag by rostra referable to three species, namely, *Choneziphius planirostris*, *C. planus*, and *C. Packardi*. A periotic bone in the Museum of Practical Geology is referred by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887) to this genus and provisionally to the first of these three species.

CHONEZIPIHIUS PLANIROSTRIS, CUVIER.

PLATE VIII., FIG. 6.

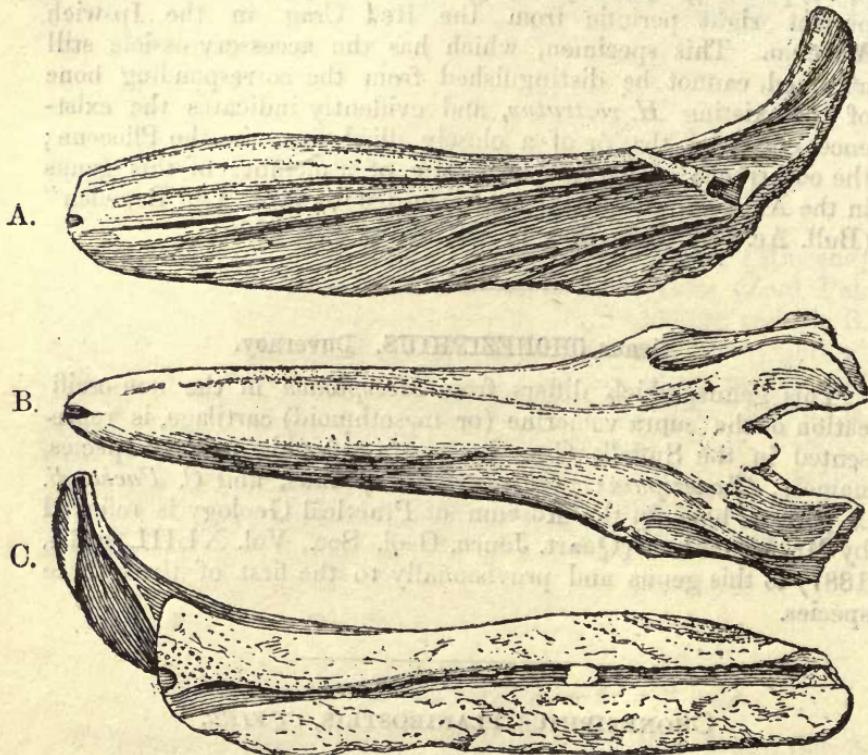
Ziphius planirostris was the name given by Cuvier (Ossem. Foss., Vol. V., Part 1, p. 352, 1823) to a rostrum from the Antwerp Crag; which was afterwards called *Choneziphius* by Duvernoy

(Ann. Sci. Nat., Ser. 3, Vol. XV., p. 63, 1851). The same form has been recorded from the Pliocene near Siena, Italy, by Prof. Capellini (Atti R. Ac. Lincei, Ser. 4, Vol. I., p. 18, 1885); and specimens of rostra in the British Museum from the Suffolk Red Crag Nodule-bed have been identified by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887, and Cat. Foss. Mamm., Part v, p. 64, 1887) as well as a periotic bone, from the same horizon, in the Museum of Practical Geology, which is provisionally referred to this species.

A caudal vertebra from the Coralline Crag in the British Museum (No. 33,459) may perhaps belong here (Cat. Foss. Mamm. Part v, p. 66, 1887).

The specimen figured below, in illustration of this species, was dredged off the Essex coast, but evidently came from the Nodule-bed of the Red Crag; it is the left half of a rostrum which has been split vertically in the middle line. The outer view (fig. A) shows the characteristic form and enlargement of the anterior premaxillary region. The maxillary and submaxillary canals are shown, as well as the union of several canals in one cavity at the hinder part of the maxillary bone.

CHONEZIPIHIUS PLANIROSTRIS.



Rostrum in the possession of the Rev. A. D. Philps, of Coggeshall. One fifth natural size. A. Outer view of left side, showing anterior end of the mesethmoid cavity. B. Restored view of upper surface. C. Inner view, showing longitudinal section of rostrum, exposing the cavity left by the unossified mesethmoid.

On the inner side (fig. C), running from end to end, is seen the fissure which was occupied by so much of the mesethmoid cartilage as remained unossified. The sides and lower edge of this fissure, where they have been in contact with the cartilage, are smooth and longitudinally grooved; but the upper surface is rough and deeply pitted, evidently indicating an edge of cartilage gradually undergoing ossification. The rough surface extends backwards for about 12 inches, at which point the roof of the fissure descends and meets the floor, leaving a slight opening at the side. Behind this the roof is formed of broken cancellous bone, and it seems probable that a median bony septum occupied the whole of this hinder part of the cavity, thus obliterating the fissure, with the exception of a mere film of cartilage, or membrane, on each side. Some of the specimens of *C. planirostris* in the British Museum seem to have the hinder part of the mesethmoid region similarly ossified; and thus when viewed from behind this region appears as completely ossified as in *Mesoplodon*; but although a portion of the upper part of this cartilage has been ossified throughout its length, yet the lower part of the anterior 12 inches remained cartilaginous in this specimen. To what extent the side walls of the fissure are due to ossification of the mesethmoid it is difficult to say, but certainly the conformation at the back closely resembles that found in *Mesoplodon*, and appears to indicate that the median mass is really the mesethmoid, which, however, never seems to reach the upper surface of the rostrum; but is overlaid by the premaxillæ; no information on this point can be obtained from Mr. Philps' specimen, which is, unfortunately, imperfect at the hinder part of the premaxillary region.

CHONEZIPIHIUS PLANUS, OWEN.

This species was originally described by Sir R. Owen (Pal. Soc. 1870, p. 16) under the genus *Ziphius*, the type being a much denuded specimen, from the Red Crag of Shotley, Suffolk, preserved in the British Museum (Cat. Foss. Mamm., Part v, p. 67, 1887) and it was referred to the genus *Choneziphius* by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, p. 418, 1880).

CHONEZIPIHIUS PACKARDI, LANKESTER.

Choneziphius Packardi was established by Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXVI., p. 502, Pl. xxxiv, 1870) for the reception of a rostrum from the Red Crag Nodule-bed of Felixstow, preserved in the Ipswich Museum. Mr. Lydekker suggests the possibility of this species being identical with the *C. planus* (Quart. Journ. Geol. Soc., Vol. XLIII., p. 14, 1887). The type specimen of the latter, however, is too imperfect to admit of comparison.

Genus MESOPLODON, Gervais.

This genus is now held to include the *Belemnoziphius*, Huxley, and the species from the Red Crag referred by Owen to *Ziphius*, except *Ziphius planus* which belongs to the genus *Choneziphius*.

Elongated cetacean vertebræ, agreeing in form with those found in this genus, are met with in the Red Crag, and doubtless belonged to some of the species, the rostra of which have been recorded from that horizon. Mr. A. Savin, of Cromer, possesses a similarly elongated vertebra from the "Forest Bed" near Cromer, which is provisionally referred to this genus.

A periotic bone in the Museum of Practical Geology, from the Nodule-bed of the Red Crag of Woodbridge, has been identified by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 15, 1887) as belonging to this genus; he provisionally includes it with *M. longirostris*, and says: "The characteristic features of the periotic of *Mesoplodon* are the production and pointed extremity of the posterior portion, the comparatively small vertical height of the longitudinal articular ridge on the tympanic aspect of the same, the small size and oval shape of the accessory ossicle, and the deep transverse concavity of the anterior articular facet for the tympanic."

Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 118, 1871) includes *Belemnoziphius* among the vertebrate remains, found by Mr. Colchester, in the Nodule-bed below the Coralline Crag, at Sutton.

MESOPLODON LONGIROSTRIS, CUVIER.

PLATE VIII., FIG 7.

In accordance with the work of Mr Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 15, 1887, and Cat. Foss. Mamm. Brit. Mus., Part v, p. 68, 1887) the following names are included in the species *M. longirostris*, namely, *Dioplodon Becanii*, Gervais (Zool. Pal. Fr., edit. 2, p. 290, pl. 38, f. 4, 1859, and Ostéogr. Cétacés, p. 420, 1880); *Ziphius medilineatus*, Owen (Pal. Soc., 1870, p. 22); *Dioplodon longirostris* and *D. medilineatus*, Capellini (Mem. Ac. Sci. Inst. Bologna, Ser. 4, Vol. VI., pp. 294 and 298, 1885).

The locality from which Cuvier's type rostrum was obtained is not known, but specimens found in the Antwerp Crag and also in the Nodule-bed of the Red Crag of Suffolk have been referred to *M. medilineatus*, and are now included in this species. Portions of rostra from the Pliocene of Italy have been described by Prof. Capellini (*loc. cit.*) and also referred to *M. medilineatus*. A small periotic bone in the Museum of Practical Geology, from the Nodule-bed of the Red Crag of Woodbridge, Mr. Lydekker thinks may belong "to this or one of the equal-sized species."

MESOPLODON TENUIROSTRIS, OWEN.

The rostrum named *Ziphius tenuirostris* by Sir R. Owen (Pal. Soc., 1870, p. 24) was obtained from the Red Crag Nodule-bed of Suffolk, and is preserved in the British Museum (Lydekker, Quart. Journ. Geol. Soc., Vol. XLIII., p. 15, 1887, and Cat. Foss. Mamm. Part v, p. 71, 1887). Prof. Capellini (Mem. Ac. Sci. Inst. Bologna, Ser. 4, Vol. VI., p. 296, 1885), has recognised it in the Pliocene near Orciano in Italy.

MESOPLODON GIBBUS, OWEN.

This species like the last was established by Sir R. Owen (Pal. Soc. 1870, p. 17, 1870) for a ziphoid rostrum from the Nodule-bed of the Red Crag of Suffolk, which is now in the British Museum (Cat. Foss. Mamm., Part v, p. 72, 1887). The species has been likewise recognised by Prof. Capellini in the Pliocene of Serastretta, Italy.

MESOPLODON ANGUSTUS, OWEN.

Another form of ziphoid rostrum from the Nodule-bed of the Red Crag of Suffolk was thus named by Sir R. Owen (Pal. Soc., 1870, p. 19.) It has not hitherto been recognised elsewhere. The type is in the British Museum (Cat. Foss. Mamm., Part v, p. 72, 1887).

MESOPLODON ANGULATUS, OWEN.

This also is one of the species established by Sir R. Owen (Pal. Soc., 1870, p. 20) for a ziphoid rostrum from the Nodule-bed of the Red Crag of Suffolk and the specimen is preserved in the British Museum (Cat. Foss. Mamm., Part v, p. 73, 1887).

A rostrum from the Antwerp Crag has, with some doubt, been referred to this species by Profs. Van Beneden and Gervais (Ostéogr. Cétacés, p. 422, 1880).

MESOPLODON COMPRESSUS, HUXLEY.

Prof. Huxley (Quart. Journ. Geol. Soc., Vol. XX., p. 388, 1864) described a rostrum from the Red Crag (Nodule-bed) of Blackheath, near Ipswich, under the name of *Belemnoziphius compressus*; and the specimen is preserved in the Museum of Practical Geology. Sir R. Owen afterwards (Pal. Soc. 1870, p. 25) described another rostrum from the Red Crag of Suffolk, which is now in the

British Museum (Cat. Foss. Mamm., Part v, p. 73, 1887) to which he gave the same specific name, but did not say whether he regarded it as the same as Prof. Huxley's species. The two specimens are similarly compressed and the convexity of the upper surface is similar but there are differences of proportion, to be seen by comparing Prof. Huxley's figure A. with Sir R. Owen's pl. V., fig. 3, which seem to indicate something more than individual peculiarities; but until these differences can be clearly defined it is better to keep them as one species.

MESOPLODON FLORIS, NEWTON.

(= *MESOPLODON FLOWERI*, *CANHAM, MS.*)

The name of *Mesoplodon Floweri* was proposed by the Rev. H. Canham, for a ziphoid rostrum from the Nodule-bed of the Red Crag at Trimley, which is now preserved with the rest of his collection in the Ipswich Museum. This name was adopted by Prof. Flower (Cat. Vert. Mus. R. Coll. Surg., Part ii, p. 562, 1864) and by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII, p. 15, 1887) and the specimen has since been described (Newton, Quart. Journ. Geol. Soc. Vol. XLVI., p. 448, Plate xviii, Figs. 7a, b, c). The well ossified mesethmoid forming a prominent feature on the upper surface of this rostrum shows at once that it is to be referred to *Mesoplodon* and not to *Choneziphius*. The mesethmoid does not, however, extend to the front of the rostrum, but ends in a point about $4\frac{1}{2}$ inches therefrom, and from here to the anterior extremity the premaxillæ are in contact, their upper surfaces being flattened and giving to this portion of the rostrum a peculiar quadrate appearance, which is one of the striking and characteristic features of the specimen. These characters are quite unlike those of any other known species of *Mesoplodon*. The term *Mesoplodon Floweri* was first used by Julius von Haast (Proc. Zool. Soc., 1876, p. 478) for a recent species of this genus, which is now believed to be identical with one previously described; as, however, the retention of the same name for another species would be likely to lead to confusion, Mr. Canham's fossil rostrum is to be called *Mesoplodon Floris*.

MESOPLODON SCAPHOIDES, NEWTON.

There is in the Museum of Practical Geology a remarkably short ziphoid rostrum from the Nodule-bed of the Red Crag near Woodbridge, which has been named *M. scaphoides* (Quart. Journ. Geol. Soc., Vol. XLVI., Plate xviii., Fig. 8, 1890) on account of its resemblance to the prow of a boat. While all other rostra described from this deposit are elongated forms, this is characterised by the very opposite peculiarity, being only about $5\frac{1}{2}$ inches in length. At first sight it might be thought to be a broken and

much rolled portion of a longer specimen, but the manner in which the lateral channels curve upwards towards the front, is quite unlike any of the known Crag forms, and seems to show that the specimen could not have been much longer when perfect. The inesethmoid is completely ossified and occupies a considerable portion of the upper surface, apparently extending to the anterior extremity, but in the front half of the specimen the sutures are completely obliterated.

SQUALODONTIDÆ.

Genus SQUALODON, Grateloup.

SQUALODON ANTWERPIENSIS, V. BENEDEEN.

PLATE VIII., FIGS. 15, 16a, b.

The name of *Squalodon antwerpiensis* was given by Prof. Van Beneden (Mem. Ac. R. Belg., Vol. XXXV. Part iii, 1865, and Vol. XXXVII., Part v, 1869) to the remains of a remarkable cetacean from the Antwerp Crag, and Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXI., p. 231, 1865) with some hesitation referred to the same genus, certain teeth from the Nodule-bed of the Red Crag of Suffolk which were elongated and possessed nipple-like enamel crowns; these, however, have not the flattened form which characterises even the anterior teeth of *Squalodon*, and they are now referred with more probability of correctness to the genus *Hoplocetus* (Lydekker, Quart. Journ. Geol. Soc., Vol. XLIII., p. 15, 1887).

Prof. Lankester (Geol. Mag., Vol. V., p. 258, 1868) also called attention to another remarkable tooth in these words:—"I have to record a new cetacean from the Suffolk Bone-bed, indicated by a flattened foliaceous tooth with a denticulate margin, probably belonging to the genus *Squalodon*." Several teeth of this form have since been obtained from the Suffolk Nodule-bed, good examples of which are preserved in the Museums of York and Ipswich, and there is now no question as to their belonging to the genus *Squalodon*, and in all probability to the *S. antwerpiensis*, Van Beneden.

The tooth from the Red Crag near Woodbridge which Prof. Lankester (Annals, Ser. 3, Vol. XIV., p. 35. 1864), thought might belong to *Ursus arvernensis*, has very coarse enamel, unlike that of any bear, and agreeing much more with some of the anterior teeth of *Squalodon*; provisionally, therefore, it is included in the present species (Pl. viii., fig. 16).

This genus has been fully illustrated by Profs. V. Beneden and Gervais (Ostéog. Cétacés, p. 438, Plate xxvii., 1880).

DELPHINIDÆ.

Genus ORCA, Gray.

ORCA CITONIENSIS, CAPELLINI.

PLATE VII., FIG. 4, and PLATE VIII., FIG. 5.

A large portion of a Delphinoid skeleton from Pliocene beds at Cetona have been described by Prof. G. Capellini (Mem. Ac. Sci. Inst. Bologna, Ser. 4, Vol. IV., p. 665, 1883) and named *Orca citoniensis*, and Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 15, 1887) refers to the same species two specimens from the Red Crag Nodule-bed of Suffolk. The first of these is a right periotic bone in the Museum of Practical Geology which while agreeing in form with that of *Orca gladiator* is much smaller. The second specimen is a tooth in the Ipswich Museum, which probably belongs to the same form as the periotic bone, and agrees with the teeth of *Orca citoniensis*.

ORCA GLADIATOR, GRAY.

(Killer or *Grampus*.)

While this Memoir is passing through the press, Mr. Savin has sent me some specimens recently obtained from the Forest-bed, two of which are referable to the Killer (*Orca gladiator*). One of these, from East Runton, is the centrum of a dorsal vertebra, with the bases of the transverse processes preserved, which agrees in size and proportions with one of the hinder dorsal vertebrae of the *Orca gladiator* preserved in the Royal College of Surgeons.

The length of the centrum is 113 mm. (nearly 4½ inches), the width of the posterior face 113 mm. and its height 103 mm. The anterior face has the same height as the posterior, but its width is less, 106 mm. The under surface and sides of the centrum are concave from before backwards, but rounded from side to side. The upper, neural, surface is wide and flattened, with two large foramina, one on each side of the middle line, a little towards the front. The terminal faces are nearly flat and the epiphyses are firmly ankylosed.

The second specimen is a tooth from the Forest-bed of Pakefield, it measures 76 mm. in length and 65 mm. in circumference at its widest part. The enamel crown, which is somewhat broken, is curved and nearly round, while the rest of the tooth is inflated, but somewhat flattened, with a depression along one side, and is marked by irregular concentric rings. This tooth agrees precisely with one of the smaller teeth of the Killer. In size, but

not in form, it agrees with the tooth from the Red Crag, referred to *Orca citoiensis*, by Mr. R. Lydekker.

The Killer is now living in the Atlantic, as far north as Greenland. It is not uncommon on the north British coasts, and occasionally comes as far south as the Thames; it has been met with in the Mediterranean.

Genus **PSEUDORCA**, Reinhardt.

PSEUDORCA CRASSIDENS? OWEN.

Another cetacean vertebra which Mr. A. Savin has sent me from the Forest-bed of Mundesley, represents a species not previously known to occur at this horizon.

The specimen is an imperfect atlas vertebra to which the small second cervical vertebra is firmly ankylosed, and the third vertebra seems to have been partly fixed to the second. A detached fragment of the neural canal shows that several of the neural arches were united into a single bony mass. This atlas is smaller and more depressed than the same bone in *Orca gladiator*, and larger than the very similar vertebra of *Tursiops tursio*. On comparison with recent skeletons it seems to come nearest to *Pseudorca crassidens*, so near indeed that provisionally it is referred to that species.

P. crassidens was specifically named by Sir R. Owen (Brit. Foss. Mamm., p. 516, 1846) from a skeleton found in the Fens, near Stamford, and to this species Prof. Reinhardt (Overs. Dan. Selsk. Forh., 1862, p. 151) referred a North Sea cetacean, specimens of which had been stranded on the Danish coast. Prof. Flower now associates with *P. crassidens* the *Orca meridionalis* which he described (Proc. Zool. Soc. 1864, p. 420) from a Tasmanian specimen.

Genus **GLOBICEPHALUS**, Lesson.

GLOBICEPHALUS UNCIDENS, LANKESTER.

PLATE VII., FIGS. 5, 6, and PLATE VIII., FIG. 8.

Prof. Lankester (Ann. Mag. Nat. Hist. Ser. 3, Vol. XIV., p. 356, 1864) described two teeth from the Red Crag Nodule-bed of Suffolk, which he referred to the genus *Delphinus* and named *D. uncidens*. In this species he also included a periotic bone from the same horizon (*loc. cit.*, Plate viii, figs. 2, 3) while some rather larger teeth and "petro-tympanics" were named *D. orcoides*. Prof. Lankester (Quart. Journ. Geol. Soc., Vol. XXVI., p. 512, 1870) subsequently alluded to the *Delphinoid* remains of the Red Crag as "of probably two species."

Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 16, 1887) in his more recent revision of the Crag Cetacea, has come to the conclusion that the two forms of teeth described by Prof. Lankester really belong to one species, he says: "The next form for consideration is that to which Prof. Lankester applied the name *Delphinus uncidens* (the generic term being used in the Linnean sense), with which *D. orcoides* of the same author may be united, since the larger teeth to which the latter name was applied are merely the hinder ones of the same species. Some confusion occurs in the description of the larger teeth, since they are stated to agree in size with those of *Pseudorca* and *Orca*, whereas they really correspond in this and other respects with those of *Globicephalus*, to which genus they may be referred. The evidence for this reference does not, however, depend solely upon the teeth, since there is in the British Museum a very beautiful associated left periotic and tympanic from the Coralline Crag, (the former bone being represented in [Quart. Journ. Geol. Soc.] Plate II., fig. 11) which agree precisely in size with the corresponding bones of *G. melas*, and only present slight structural differences of specific value."

The periotic bones figured by Profs. Van Beneden and Gervais (Ostéographie de Cétacés, Plate lx, figs. 1 and 8), from Italy and the Suffolk Crag, seem to be specifically identical with that figured by Mr. Lydekker, and there is another periotic from the Red Crag Nodule-bed of Woodbridge, referable to the same species, in the Museum of Practical Geology (Plate VIII., fig. 8).

The periotic bone figured by Prof. Lankester (*loc. cit.*, Plate viii., fig. 2, 3) as *D. uncidens* has not the same form as that which Mr. Lydekker (*loc. cit.*, Plate ii., fig. 11) now refers to *G. uncidens*. A lumbar vertebra from the Red Crag, in the British Museum (No. 28,271) and possibly some vertebra from the Antwerp Crag in the Brussels Museum, are referred by the last-named writer to the present species.

Mr. E. Cavell, of Saxmundham, has a tooth agreeing with this species, from the Norwich Crag of Thorpe. *Globicephalus uncidens* has thus been recognised in the true Coralline Crag, the Red Crag Nodule-bed, and in the Norwich Crags; possibly also in the Antwerp Crag.

Genus MONODON, Linnæus.

MONODON MONOCEROS, LINNÆUS.

(*Narwhal.*)

(Vert. Forest Bed, PLATE IX., FIG. 2.)

The occurrence of the Narwhal in the Cromer Forest-bed has long been known, and references will be found in the Survey

Memoir (Vert. Forest Bed., p. 109, 1882). Since then an interesting specimen of an aborted tusk *in situ* has been found by Mr. Savin (see Geol. Mag. Dec. 3., Vol. VI., p. 148, 1889) and there is in the Museum at York what appears to be the swollen base of a similarly aborted tusk from the Suffolk Red Crag Nodule-bed. This species has also been recorded (Woodward, Mem. Geol. Surv., Geology of Norwich, p. 96, 1881) from the Pleistocene Brickearth of Sprowston, near Norwich, and the specimen is in the Norwich Museum.

M. monoceros is now living in the Arctic seas between latitudes 70° and 80° and has occasionally been found on the British coasts.

Genus **DELPHINAPTERUS**, Lacépède.

DELPHINAPTERUS LEUCAS, PALLAS.

(*White Whale.*)

A caudal vertebra, from the Forest-bed of East Runton, near Cromer, in the collection of Mr. A. Savin, has been referred to this species (Geol. Mag. Dec. 3., Vol. VI., p. 148, Plate v., Fig. 3, 1889), and probably also a lumbar vertebra from the same horizon at Overstrand, also in Mr. Savin's collection. The species has been identified from Pleistocene deposits by Mr. Lydekker (Cat. Foss. Mamm. Brit. Mus., Part v., p. 79, 1887) and it is now living in the Arctic seas, occasionally visiting the northern coasts of Britain.

There are two caudal vertebræ in the Museum of Practical Geology, from the Red Crag, which closely resemble the corresponding vertebræ of this species.

Genus **DELPHINUS**, LINNÆUS.

DELPHINUS DELPHIS, LINNÆUS.

(*Dolphin.*)

(Vert. Forest Bed, p. 110, PLATE VI., FIG. 2.)

Specimens in the Norwich Museum from Fluvio-marine Crag, Chillesford beds, of Aldeby were identified by Prof. Flower some years since; and vertebræ, which cannot be distinguished from those of *D. delphis*, have been found in the Forest-bed of Overstrand, near Cromer.

Genus *TURSIOPS*, Gervais.*TURSIOPS (DELPHINUS) TURSIO?* BONNATERRE.

(Bottle-nosed Dolphin.)

PLATE VIII. FIGS. 14a, b.

A delphinoid vertebra indicating a form about twice the size of the common dolphin and nearly as large as the example of *Tursiops (Delphinus) tursio* in the Museum of the Royal College of Surgeons, has been found in the Forest-bed near Cromer (Mem. Geol. Surv., Vert. Forest Bed, p. 111, 1882).

Mr. Lydekker (Cat. Foss. Manm. Brit. Mus., Part i., p. 84, 1887, No. 35,042a) has noted a vertebra of a closely allied form from the Coralline Crag of Ramsholt, and another from the Pleistocene, of Grays, Essex. There are two vertebræ, probably belonging to the same species, in the Museum of Practical Geology, also from the Coralline Crag itself (not from the Nodule-bed beneath). One of these is from the caudal region and was obtained by Mr. Clement Reid in the Broom Pit at Gedgrave; it has the transverse process perforated vertically, and the neural spine seems to have been more slender than in *T. tursio*, but this may be due to its being imperfect. The second specimen is a much broken lumbar vertebra from Orford.

Van Beneden and Gervais (Ostéog. Cétacés, p. 253, 1880) refer to specimens from the Peat (Cambridgeshire?) agreeing with *Delphinus tursio*.

Tursiops tursio is now living in the Atlantic and is represented by a closely allied, if not identical form, in the Peat, Pleistocene, Forest-bed, and Coralline Crag of the east of England.

Genus *PHOCÆNA*, Cuvier.*PHOCÆNA COMMUNIS*, LESSON.

(Porpoise).

A caudal vertebra of this species has been identified (Geol. Mag. Dec. 3., Vol. VI., p. 149, Plate v., fig. 4, 1889) from the Forest-bed of Sidestrand near Cromer, and is in the collection of Mr. A. Savin.

Phocæna communis is now living in the North Atlantic and around the coasts of Great Britain.

DELPHINOID PETROTYMPANICS, not generically determined.

PLATE VIII., FIGS. 9-12.

A number of small Delphinoid periotics and tympanics, from the Red Crag, which are to be seen in different collections, and

four "from the Coralline Crag of Beccles Old Abbey, Suffolk," in the British Museum* (No. 30,265), have yet to be identified or described. Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLIII., p. 16, 1887, and Cat. Foss. Mamm. Brit. Mus. Part v., p. 84, 1887) in speaking of these undetermined specimens says they "indicate a Dolphin agreeing in size with the existing *Lagenorhynchus acutus* and may be identical with one or both of two Belgian species to which Prof. Van Beneden has applied the name of *Delphinus Wasii* and *D. Delannoyi* (the generic term being used in a wide sense). The specimens in the Brussels Museum do not, however, include any examples of the periotic, so that I could not institute any comparison between the Belgian and the English specimens." Among the examples of unnamed periotics in the Museum of Practical Geology I recognize three forms which appear to represent three distinct species; one of these (Plate VIII., fig. 11) has the anterior foramen of the inner side included in the large fossa above the cochlea, and together they form an elongated oblique depression placed nearly horizontally and the articular surface for the tympanic is broad and concave. These may be young examples of *Globicephalus uncidens*. The second form of periotic (Plate VIII., fig. 10) has, in most cases the anterior inner foramen distinct from the supra-cochlea fossa, but when they are united the depression is more nearly vertical than in the previous form, though still oblique; and the tympanic articulation is more elongated and less concave or even inflated. This is the form figured by Prof. Lankester (Ann. Mag. Nat. Hist. Ser. 3, Vol. XIV., Plate viii., figs. 2, 3, 1864) and provisionally included in his *Delphinus uncidens*. (See p. 77.) The third form of periotic (Plate VIII., fig. 12), has the elongated supra-cochlea depression nearly horizontal as in the first form, and the tympanic articulation elongated and inflated as in the second form.

Another large periotic in the Museum of Practical Geology from the Red Crag Nodule-bed of Woodbridge (Plate VIII., fig. 9) has yet to be generically determined. Fig. 13 on same plate is an undetermined tympanic.

Two small delphinoid vertebræ from the Norwich Crag, Wigham Collection, are preserved in the British Museum (33,504, 33,505) (Cat. Foss. Mamm. Part v., p. 83, 1887).

* There is some error as to the horizon and locality of these specimens, which were purchased by the British Museum in 1855 from Mrs. Nixon, for there seems to be no such place as Beccles Old Abbey, Suffolk; and the Coralline Crag does not occur near Beccles. It has been suggested that "Leiston Old Abbey" is the place meant, but there is no outcrop of Coralline Crag within three or four miles. Red Crag occurs near Leiston, but the specimens are not hard and phosphatised like specimens from the Nodule-bed, and it is unlikely that four specimens like this should be found in the Red Crag proper.

NOTES on MAMMALS which have been said to occur in the
ENGLISH CRAGS.

Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 212, 1872) have included in their list of Upper Crag Mammals *Felis catus* and *Arvicola campestris*, but I have not been able to corroborate the occurrence of either of these species. The first-named, *F. catus*, seems to have been given on the authority of Mr. J. Gunn; but there was some error as to the age of the specimens. The same authors have also given in their Middle Crag list; *Vespertilio* sp., *Sus arvernensis*, *Ziphius declivus*, and *Z. undatus*. The last two were Sir R. Owen's MS. names, and they do not occur in his Monograph of the Red Crag Cetacea (Pal. Soc., 1870), they must therefore be expunged. The specimens referred to as *Sus arvernensis* are probably those which are called *S. palaeochœrus*. I can get no clue to anything from the Red Crag which could be called *Vespertilio*, and am obliged to conclude that it was erroneously inserted.

Prof. Owen (Brit. Foss. Mamm., p. 111) thus speaks of a specimen said to have been found in the Red Crag of Newbourn, Suffolk:—"A fossil skull of a Badger in the Museum of the Philosophical Institution at York," which "Prof. Phillips assures me has the same mineralised condition and general appearance which characterise the ordinary recognised fossils of that miocene [pliocene] formation."

I find on inquiry that this skull has since been rejected from the York Museum, on account of its not having really come from the Crag; and consequently *Meles taxus* can no longer be retained as a Crag species.

Although Mr. R. Lydekker has referred (Cat. Foss. Mamm. Brit. Mus., part v., p. 62, 1887) to two vertebræ from the Red Crag of Suffolk, as being very like those of *Kogia*; he has not felt satisfied that they really represent that genus.

1881, 38, p. 7. *Particulars of the Red Crag of Suffolk*

AVES.

The remains of Birds are of rare occurrence in beds of Pliocene age, and of those which have been found only a few are sufficiently perfect to allow of their identification. Nevertheless such remains have been met with throughout the British Pliocene strata, and several forms recognized in the Coralline Crag, Red Crag, Norwich Crag, and Forest-bed.

Genus *BUBO*, Cuvier.

BUBO IGNAVUS, FORSTER.

(= *B. MAXIMUS*, FLEMING.)

(Eagle Owl.)

PLATE IX., FIGS. 4a, b, c.

The greater part of a very well preserved tarso-metatarsus obtained by Mr. A. Savin from the Forest-bed at East Runton has been referred to this species (Geol. Mag., Dec. 3., Vol. IV., p. 146. 1887). There is much variation in the robustness of the tarso-metatarsus in different specimens of the *B. ignavus*, but the Forest-bed specimen comes within the limits of this variation, and in other respects agrees with the recent form.

Bubo ignavus is met with in Europe at the present day in suitable localities, from Lapland to the Mediterranean, and a few examples have been recorded in the North of Scotland and even in England.

Genus *PHALACROCORAX*, Brisson.

PHALACROCORAX CARBO, LINNÆUS.

(Cormorant.)

PLATE IX., FIG. 6.

The upper part of a coracoid, presenting the peculiarities found in the same bone of the Cormorant, is believed to indicate the occurrence of that species in the Forest-bed, the specimen having been found in that deposit at West Runton by Mr. W. Barker. (Geol. Mag., Dec. 3, Vol. IV., p. 147, 1887.)

The Cormorant, according to Mr. Howard Saunders (British Birds, p. 349, 1888), is living at the present day as far north as Greenland, to about 70° north lat.; throughout Europe, and the greater part of Asia; also in North Africa, and possibly South Africa as well. It is known on the Atlantic side of North America, but apparently not on the Pacific side. A nearly allied, if not identical, species occurs in Australia and New Zealand.

Genus **ANSER**, Brisson.**ANSER** sp.

(Goose.)

(Vert. Forest Bed, p. 112, PLATE XVII., FIG. 1.)

A portion of a metacarpal bone, from the Forest-bed of East Runton, which agrees with that of the common Goose, has been referred to this genus.

Genus **ANAS**, Linnæus.**ANAS** ? sp.

(Duck.)

(Vert. Forest Bed, p. 113, PLATE XVII., FIG. 2.)

A portion of a coracoid and a metacarpal from the Forest-bed of West Runton have been thought to belong to this genus.

Genus **SPATULA**, Boie.**SPATULA CLYPEATA**, LINNÆUS.

(The Shoveller.)

PLATE IX., FIGS. 7a, b.

A perfect coracoid, obtained by Mr. W. Barker from the Forest-beds at West Runton, agrees so exactly with the same bone in the Shoveller duck that it has been referred to the same species. (Geol. Mag., Dec. 3, Vol. IV., p. 146, 1887.)

This species has at the present day a very wide distribution, having been found over the greater part of the Northern hemisphere, and extending from near the Arctic circle southward in the old world to Egypt and Abyssinia, India, and Southern China, and in America from Alaska to Panama; while it is said to have been met with in Australia.

Genus **URIA**, Brisson.**URIA TROILE**, LINNÆUS.

(Common Guillemot.)

PLATE IX., FIGS. 5a, b.

A humerus belonging to this species was recognised some years ago by Prof. Flower (Proc. Norwich Geol. Soc., Vol. I., p. 27, 1878) in a collection of fossils from the Chillesford Crag of Aldeby, made by Messrs. Crowfoot and Dowson. This determination has been recorded by Mr. H. B. Woodward (Mem. Geol.

Surv., Geology of Norwich, p. 54, 1881), and the specimen is now in the Norwich Museum. Mr. R. E. Leach has a portion of a metatarsal, from the Norwich Crag of Yarn Hill, which agrees so closely with that of the Common Guillemot as to leave no doubt that it belongs to this or a closely allied species.

The Common Guillemot is now living on the western coasts of Europe, ranging as far north as Bear Island; it is also found in the Baltic and on the coasts of North America.

Genus **MERGULUS?** Vieillot.

Mr. R. E. Leach also has a part of a small avian femur from Yarm Hill, which agrees very closely with the same bone in the Little Auk (*Mergulus alle*); but the evidence is not sufficient to justify a definite reference to that species; it is, however, provisionally referred to the above genus.

Genus **DIOMEDEA**, Linnæus.

DIOMEDEA sp.

(*Albatross.*)

PLATE IX., FIGS. 2, 3.

A right tarso-metatarsus, with a first phalangeal bone of the fourth digit, from the Red Crag, was, it appears, generically identified some years ago by Mr. Gerrard of the British Museum, and has since been described by Mr. Lydekker (Quart. Journ. Geol. Soc., Vol. XLII., p. 366, 1886).

This tarso-metatarsus is intermediate in size between that of *Diomedea exulans* and that of the smaller, *D. melanophrys* and *D. chlororhyncha*; but no specific determination has been made. These bones, which are now in the Ipswich Museum, were found in the sandy bed overlying the shelly Red Crag at Foxhall, and are most probably of Red Crag age.

The wing bone (part of an ulna) from the Coralline Crag of Orford, presented to the Museum of Practical Geology, by Colonel Alexander, and alluded to by Mr. Lydekker (*loc. cit.*) as, perhaps, belonging to the present form, I have compared with the wing bones of the recent species of *Diomedea* and have no doubt as to its belonging to the same genus.

The Museum of Practical Geology also possesses a perfect ulna of *Diomedea*, from the Pleistocene, which cannot be distinguished from the ulna of *D. exulans*. This bone forms part of the Cotton Collection of Vertebrate remains from the Brickearth of Ilford.

There are in the Ipswich Museum several skulls of turtles from the Red Crag of Suffolk, and there is one in the British Museum; but they have, in all probability, been derived from some earlier formation, and have not been generically determined.

REPTILIA.

CHELOMIA.

There are in the Ipswich Museum several skulls of turtles from the Red Crag of Suffolk, and there is one in the British Museum; but they have, in all probability, been derived from some earlier formation, and have not been generically determined.

SQUAMATA.

Genus **TROPIDONOTUS**, Kuhl.

TROPIDONOTUS NATRIS, LINNÆUS.

(*Common Snake.*)

(Vert. Forest Bed, p. 114, PLATE XVII., FIGS. 4, 5.)

Two vertebræ belonging to Mr. E. T. Dowson, from West Runton, and two from Bacton in the Museum of Owen's College, Manchester, represent the common snake in the Forest-bed.

The species is now living in Middle and Southern Europe.

Genus **PELIAS**, Merrem.

(*VIPERA*, Laurenti.)

PELIAS BERUS, LINNÆUS.

(*Viper.*)

(Vert. Forest Bed, p. 115, PLATE XVII., FIG. 6.)

The viper is represented in the Forest-bed by a single vertebræ from West Runton, which is preserved in the Museum of Practical Geology.

The species is now living throughout Europe.

A M P H I B I A.

Genus *RANA*, Linnæus.

RANA TEMPORARIA, LINNÆUS,

(Common Frog.)

(Vert. Forest Bed, p. 117, PLATE XVII., FIG. 7.)

Humeri and other bones referable to this species have been found in the Forest-bed at West Runton and at Sidestrand.

The species is now living throughout Europe, and also in Asia, Japan, and North America.

RANA ESCULENTA, LINNÆUS

(Edible Frog.)

Bones which are believed to belong to this species have been found in the Forest-bed at West Runton. (Mem. Geol. Surv., Vert. Forest Bed, p. 118, 1882.)

Now living in Europe, China, and Japan.

Genus *BUFO*, Laurenti.

(Vert. Forest Bed, p. 118, PLATE XVII., FIG. 8.)

Bones of this genus have been found in the Forest-bed at West Runton.

Genus *TRITON*, Laurenti.

(MOLGE, Merrem.)

TRITON CRISTATUS, LAURENTI.

(Newt.)

(Vert. Forest Bed, p. 119, PLATE XVII., FIG. 9.)

A single femur of this genus has been found in the Forest-bed at West Runton.

The Triton is now living throughout Europe.



PISCES.

TELEOSTEI.

Genus PERCA, Linnæus.

PERCA FLUVIATILIS, LINNÆUS.

(Perch.)

(Vert. Forest Bed, p. 120, PLATE XVIII., FIGS. 1-8.)

Scales and parts of the opercular apparatus of this fish have been found in the Forest-bed at West Runton, Beeston, Mundesley, Happisburgh, Ostend, and Kessingland.

Perca fluviatilis has also been met with in Post-glacial Beds at Hornsea, Yorkshire. (Mem. Geol. Surv., Geology of Holderness, 1885, p. 82.)

The species is now living in the rivers of Europe and Asiatic Russia.

Genus ACERINA, Cuvier.

ACERINA VULGARIS ?, CUVIER.

(Ruff.)

(Vert. Forest Bed, p. 121, PLATE XVIII., FIG. 9.)

An otolith from the Forest-bed of West Runton has been referred to this species.

The Ruff is now living in the rivers of Europe and Siberia.

Genus CHRYSOPHRYS, Cuvier.

PLATE X., FIGS. 1, 2, 3.

Certain smooth and polished fish teeth, which have long been known from the Red Crag of Suffolk, have been labelled in collections as *Chrysophrys*; but I am not aware that the occurrence of this genus in the English Crag had ever been published. These teeth vary much in shape, corresponding, apparently, to the different parts of the mouth which they have occupied, some being elongated, conical, compressed, and curved, while others are short truncated cones, or even flattened discs like those of *Pycnodus*. One specimen in the Museum of Practical Geology consists of

these conical and compressed teeth attached to what seems to be a premaxilla.

On comparing these teeth with those of the recent *Chrysophrys aurata* it will be found that although there is a general resemblance they are not precisely of the same form. The largest recent specimen I have been able to examine has the teeth much smaller than those from the Crag. Moreover, I have seen no specimen from the English Crag corresponding with the large oval tooth found in each jaw of *Chrysophrys aurata*.

Prof. Van Beneden in 1871 (Bull. Ac. Roy. Belg., Ser., 2, Vol. XXXI., p. 503) proposed the name of *Chrysophrys Hennii* for some teeth from the Antwerp Crag; but as he has given no characters, or any good reason for separating them from the recent species, his name cannot be adopted for our specimens.

Dr. E. Sismonda (Mem. R. Ac. Sci. Torino, Ser. 2, Vol. X., p. 15, 1846) described some oval flattened teeth from beds at Antigiana, Piedmont, possibly of Pliocene age, to which he gave the name of *Chrysophrys Agassizii*, but, as no such oval teeth have been met with in the English Crags, comparison cannot be made.

Seeing that the name of *Chrysophrys* has been used for these English Crag teeth, I purpose provisionally to let them remain under that genus, although the evidence is insufficient for definite identification.

In Britain these *Chrysophrys* teeth have been recognized in the Red Crag Nodule-bed of Woodbridge, Waldringfield, and elsewhere in Suffolk. There is one tooth in the Museum of Practical Geology from the true Coralline Crag of Gedgrave. Mr. J. Reeve has specimens from the Norwich Crag of Bramerton, and Mr. Lamplugh possesses examples from the Bridlington Crag. A specimen from the Weybourn Crag of East Runton is in the Museum of Practical Geology, and was figured in the Survey Memoir. (Vert. Forest Bed, Plate xix., fig. 12.) On the continent teeth referable to this genus have been found in the Pliocene at Montpellier, Roussillon, Herault, Antwerp, and Piedmont. M. Gervais (Zool. Pal. Fr., Edit. 2, p. 514, 1859), has also recorded them from the Eocene and Miocene of various localities in France, Malta, &c.

Genus PLATAX, Cuvier.

PLATAX WOODWARDI, AGASSIZ.

(Vert. Forest Bed, p. 122. PLATE XIX., FIGS. 1-3.)

The enlarged clavicles, interspinous bones, and vertebræ which were named *Platax Woodwardi* by Agassiz (Poissons Fossiles, Vol. IV, p. 250, Plate 19., figs. 3, 8, 1842-4), as well as the so-called "Butterfly bones" figured by S. Woodward (Geol. Norfolk, Plate iii., figs. 31-33, 1833), which are generally referred to the same species, are very abundant in the upper beds of the Crag. They occur in the Forest-bed (Mem. Geol. Surv., Vert. Forest Bed,

p. 122, Plate. xix., figs., 1-3, 1882), and Weybourn Crag, at several localities. A specimen from Felixstow, in the Museum of Practical Geology, is evidence of its occurrence in the Red Crag.

Prof. Prestwich noticed the presence of this fish in both the Red and Coralline Crags of Suffolk (Quart. Journ. Geol. Soc., Vol. XXVII., p. 132, 1871), and Mr. Lamplugh has specimens from the Bridlington Crag.

Mr. Fitch, of Norwich, has a bone from the Norwich Crag of Thorpe exhibiting the same peculiar hyperostosis, and in form resembles one of the enlargements seen on the skull of *Ephippius*. This specimen is provisionally included with *Platax Woodwardi*.

There are several bones in the York Museum, from the Red Crag, of different forms, but all possessing a reticulate inner structure, which seem to be hyperostoses of a similar nature to those called *Platax Woodwardi*, but their true affinities have yet to be worked out.

Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 3, Vol. I., p. 119, 1881), described several forms from the Antwerp Crag, which he believed to be related to *Platax Woodwardi*, and for these he established four new species, *P. cuneatus*, *physeteroide*, *pileum*, and *costatus*; two other forms he described as new species of *Pagrus*, namely *P. pileatus* and *P. torus*. None of these Belgian species seem to be represented in the English Crags.

Genus THYNNUS, C. & V.

THYNNUS SCALDIENSIS, STORMS.

The occurrence of the genus *Thynnus* in the Belgian Crag has been made known by Mons. Raymond Storms (Bull. Soc. Belge Géol., Vol. III., p. 163, 1880), who has given an account of a number of vertebræ from the Scaldian of Antwerp, and finds on comparing them with the skeleton of the recent *Thynnus thynnus*, that all the vertebræ, corresponding with those behind the thirtieth of the series, have a greater length in proportion to the width than in this recent species, he has therefore proposed for them the name of *Thynnus Scaldensis* (more correctly *T. scaldiensis*).

Two vertebræ in the British Museum, from the Coralline Crag of Suffolk, Mr. A. Smith Woodward (Ann. Mag. Nat. Hist. Ser. 6, Vol. V., p. 294, 1890), has referred to the Antwerp species. After having examined these specimens and compared them with the measurements of the vertebræ of the recent Tunny and with M. Storms' figures and descriptions I see no good grounds for questioning this determination, although there is now evidence of the Tunny (*T. thynnus*) in the Cromer Forest-bed.

Mr. Smith Woodward also calls attention to some other scomberoid vertebræ from the Red Crag of Woodbridge, but these are evidently derived from a much earlier horizon, probably Lower Eocene, and their generic affinities are at present uncertain.

THYNNUS THYNNUS, LINNÆUS.

(Tunny.)

PLATE IX., FIG. 8.

Early in the year 1890 Mr. A. Savin forwarded to me a large teleostean fish-vertebra, which he had discovered in the Forest-bed at East Runton, and this has enabled us to add another genus to the fauna of that horizon and another species to the British Pliocene (Geol. Mag. Dec. 3, Vol. vii., p. 264).

The processes of this vertebra have been broken off, but the centrum measures 43 mm. long, 53 mm. wide, and 45 mm. high; it is deeply biconcave, and somewhat depressed; it is further characterised by a single, large, longitudinal bar on each side, which thickens anteriorly and posteriorly, with a roughened space towards the front, which indicates the point of attachment of the rib. Above and below the bar is a deep fossa. In the upper fossa, just below the margin from which the neural arch has been broken away, there are two small foramina, the hinder one being much less than the front one. This vertebra, although a little smaller, agrees so exactly in its proportions with the nineteenth vertebra of the large Tunny (*T. thynnus*, about 8½ feet long) from the Firth of Forth, preserved in the Osteological Collection of the Royal College of Surgeons, that I have no hesitation in referring it to the same species.

The occurrence of a large Tunny (*T. scaldiensis*) in the Antwerp Crag and in the Coralline Crag of this country suggests the possibility of the Forest-bed specimen belonging to the same species; but after careful comparison, due regard being paid to the relative proportions of length to width, I find that the Forest-bed example agrees with the recent *T. thynnus*, and not with the Antwerp form.

The Tunny at the present day is abundant in the Mediterranean, and is occasionally met with as far north as the coasts of Scotland.

Genus **ANARRHICHAS, Linnæus.****ANARRHICHAS LUPUS, LINNÆUS.**

(Wolf Fish.)

PLATE X., FIGS. 4a, b.

The conical and flattened teeth which are above referred to *Chrysophrys* have sometimes been thought to belong to *Anarrhichas lupus*; but I have been unable to find any specimen from the Pliocene which could be referred to this genus except one recently obtained by Mr. Clement Reid, with a number of other small fossils, from the Coralline Crag of Gedgrave. This specimen is a curved conical tooth about the fourth of an inch long, with the lower part deeply striated, and its base showing the peculiar

labyrinthoid structure seen in the teeth of the Wolf-fish; indeed the form and structure of this tooth agrees so closely with one of the premaxillary teeth of *A. lupus*, that there can be little doubt as to its belonging to the same species.

Some of the teeth of the Angler-fish, *Lophius piscatorius* have a somewhat similar labyrinthoid plaiting at the base; but the teeth are proportionately longer and more hollow, with one side flattened for the hinge-like attachment to the jaw, and at this side the plaiting is absent; whilst in the fossil tooth the folding is continued all round. This unique specimen of *Anarrhichas lupus*, from the Coralline Crag of Gedgrave, has been presented by Mr. C. Reid to the Museum of Practical Geology.

The Wolf-fish is common in the German Ocean, still more abundant northwards, and less so southwards.

Genus LABRUS, Linnaeus.

Among the remains from the Nodule-bed of the Red Crag of Suffolk, preserved in the British Museum, there is a specimen of the united pharyngeal bones of a labroid fish (No. p. 5565) which Mr. Smith Woodward has referred to the genus *Labrus*. (Cat. Brit. Foss. Vert., p. 108, 1890.) Possibly some of the teeth which have been thought to belong to *Chrysophrys* would be more correctly included here.

Genus PHYLLODUS, Agassiz.

There are in the British Museum a number of specimens from the Suffolk Red Crag Nodule-bed belonging to this genus, which are referred to the following species:—*P. speciosus*, *hexagonus*, and *toliapicus*. These are essentially London Clay forms, and it is highly probable that they have been derived from that horizon. Similar specimens are preserved in the Ipswich Museum and in the Museum of Practical Geology.

Genus PLEURONECTES, Artedi.

Under the synonym of *Platessa*, a maxilla from the Forest-bed of Overstrand, near Cromer, was described in the Survey Memoir (Vert. Forest Bed, p. 128, 1882). There can be no question as to the generic affinities of this specimen, and it is very near to, if not identical with the common Plaice.

Genus **GADUS**, Linnæus.

Prof. Lankester in the year 1863 (Geologist, Vol. VI., p. 110) called attention to the vertebral column and fins of a fish preserved on a hardened slab of crag from Aldborough, which was thought by Dr. Günther to be probably Gadoid, and which Mr. E. T. Higgins afterwards in his paper "On the Otolites of Fish" (Journ. Linn. Soc. Zool., Vol. IX., p. 164, 1867) alluded to as undoubtedly Gadoid. A cast of this specimen is now in the Museum of Practical Geology. In the same paper Mr. E. T. Higgins says:—"All the otoliths from the Coralline Crag that I have yet had the opportunity of examining belong, without a single exception, to existing species of Gadoids, viz., Cod, Whiting, Pollack, Whiting Pout, Green Cod, &c." It would seem, however, that Mr. Higgins was afterwards less certain as to these species, for Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 132, 1871), on the authority of Mr. Higgins, gives the following as the forms of Gadoid otoliths which had been recognized in the Coralline Crag:—Common Cod, Green Cod, Power Cod:—probably identical with living species:—Pollack, Whiting, Whiting Pout, nearly allied but not identical. Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 202, 1872) subsequently added the Haddock to this list.

A large number of otoliths from the English Crags have passed through my hands, and all seem to belong, as Mr. Higgins said, to Gadoid fishes, but I have not been able to identify from the Coralline Crag all the forms above noticed. However, it is only right to say that the specimens on which Mr. Higgins based his determinations are now with him in Australia.

The larger otoliths are comparatively rare in the Coralline Crag, whilst the small ones (probably young) are much more numerous, and many of them seem to have been smoothed over and denuded, as if partially digested by other fishes.

GADUS MORRHUA, LINNÆUS.

(Cod-fish.)

PLATE X., FIGS. 5a, b.

Although Mr. Higgins (Journ. Linn. Soc. Zool., Vol. IX., p. 164, 1867) seemed tolerably certain that he had recognized the otoliths of the Cod-fish in the Coralline Crag, I have been unable to find any specimen in either the Coralline or Red Crag referable to this species; but Mr. J. Reeve, of the Norwich Museum, has two otoliths from the Lower Bed of the Norwich Crag at Bramerton which undoubtedly belong to *Gadus morrhua*.

The occurrence of jaws and other bones of this species in the Forest-bed at several localities has already been recorded in the Survey Memoir (Vert. Forest Bed, p. 127, 1882).

The Cod-fish is now living in the Northern seas of Europe and America, between latitudes 50° and 67° ; it is especially abundant on the Newfoundland Bank.

GADUS PSEUDÆGLEFINUS, n. sp.

(*Allied to the Haddock.*)

PLATE X., FIGS. 6a, b, and 7.

Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 202, 1872) included the Haddock in their list of fossils from the Coralline Crag of Suffolk; but there is no doubt that the form alluded to was the otolith now under consideration, several specimens of which are in the Museum of Practical Geology, and elsewhere, from both the true Coralline and Red Crags. These otoliths (Plate X., figs. 6a, 6b) although very similar are not identical with those of the living *G. æglefinus*, being rather more elongated and more pointed at the hinder end, some of them are likewise more strongly crenulated. I propose to name this form *Gadus pseudæglefinus*. The Museum of Practical Geology possesses a similar otolith, which was obtained from the Norwich Crag of Bramerton by the late Mr. Robert Bell.

The otoliths of young Haddocks differ from those of larger specimens in being more strongly crenulated and rather more pointed; many small otoliths from the Coralline Crag (Plate X., fig. 7) differ from those above described in a similar manner, and are therefore regarded as the young of the present species. One such otolith from the Weybourn Crag was figured in the Survey Memoir. (Vert. Forest Bed, Plate xviii., fig. 26.)

Gadus pseudæglefinus occurs therefore in the Coralline, Red, Norwich, and Weybourn Crags.

GADUS LUSCUS, LINNÆUS.

(*Whiting Pout.*)

PLATE X., FIGS. 8a, b.

The otoliths of *Gadus luscus* were doubtfully recorded from the Coralline Crag by Mr. Higgins (Jour. Linn. Soc. Zool., Vol. IX., p. 164, 1867) and Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 132, 1871), it is now represented in the Museum of Practical Geology by several specimens from the Coralline Crag of Sutton and from the Red Crag of Boyton. Examples of the otoliths of this species have been detected among specimens from the Pleistocene beds of Selsey, collected by my colleague Mr. Clement Reid.

At the present day the Whiting Pout is met with on all the coasts of Great Britain, it is found as far north as Greenland, and occasionally enters the Mediterranean.

GADUS MINUTUS, LINNÆUS.

(*Power Cod.*)

PLATE X., FIGS. 9, 10, 11.

Otoliths of this species were, like the last, recognised in the Coralline Crag by Mr. Higgins and Prof. Prestwich (*loc. cit.*). Recent specimens of *G. minutus* have the otoliths proportionally broader and less strongly nodular than those of *G. luscus* of the same size. In large examples of *G. luscus* the nodules are partially obliterated, but this is not the case in smaller ones. It is by no means easy to separate the otoliths of the two species, but there are a few from the Coralline Crag of Sutton in the Museum of Practical Geology which seem to agree best with those of *G. minutus*, and they are provisionally placed in this species.

Gadus minutus is now living on the Atlantic coasts of Europe, and is very common in the Mediterranean.

GADUS MERLANGUS, LINNÆUS.

(*Whiting.*)

PLATE X., FIGS. 12a, b.

The otoliths of this species have also been doubtfully recorded from the Coralline Crag by Mr. Higgins and Prof. Prestwich (*loc. cit.*), but I have been unable to obtain any corroborative evidence.

The late Mr. Robert Bell sent me a small Gadoid otolith from the St. Erth Pliocene deposit, which I believe belongs to this species. The specimen is about 9 mm. long and 3 mm. wide, the extreme, pointed, hinder end being broken off just at the place where the otoliths of recent Whiting so often break, there being very frequently little notches on the edge at this place, and traces of such notches are seen in this fossil. If this is not *G. merlangus* it must have been a closely allied form.

The Whiting is now living on the Western coasts of Europe, and in the Mediterranean.

GADUS VIRENS? LINNÆUS.

(Coal Fish.)

PLATE X., FIGS. 13, 14.

This is another of the Gadoid species, the otoliths of which were recognised in the Coralline Crag by Mr. Higgins and noticed by Prof. Prestwich (loc. cit.), but I have not been able satisfactorily to identify the species as a Crag fossil, although a small otolith from the Coralline Crag of Sutton, in the possession of Mr. Kendal, and two still smaller from the same place, in the Museum of Practical Geology, agree so nearly with some young examples of this species that provisionally I place them here.

Gadus virens is now living on the northern Atlantic coasts of North America, reaching as far as Spitzbergen, and on the Western European coasts as far south as the Mediterranean.

GADUS POLLACHIUS, LINNÆUS.

(Pollack.)

PLATE X., FIGS. 15a, b.

This is the sixth species of Gadoid the otoliths of which were noticed by Mr. Higgins and Prof. Prestwich (loc. cit.) in the Coralline Crag; but I have not yet been able to recognise it from that horizon, although Mr. J. Reeve has a large otolith, not quite perfect, from the Upper Bed of the Norwich Crag at Bramerton, agreeing so closely with the recent forms that I have referred it to this species. An otolith of a similar character from the Weybourn Crag at East Runton has been already placed on record (Mem. Geol. Surv., Vert. Forest Bed, p. 128, Plate xviii., fig. 24, 1882).

The Pollack is now living on the European shores of the Atlantic, and is rare in the Mediterranean.

GADUS ELEGANS, KOKEN.

PLATE X., FIG. 16.

A number of small otoliths in the Museum of Practical Geology, some from the Coralline Crag of Sutton, and others said to be from the Red Crag, have a close resemblance to those which have been referred to *Gadus pseudaglefinus*, but are proportionately broader, and in this particular they differ also from the otoliths of young Haddocks (*G. aeglefinus*). They agree, however, more closely with the otolith from the Oligocene which Herr E. Koken (Zeitsch. deutsch. geol. Ges., Vol. XXXVI., p. 544, 1884) has called *Otolithus (Gadidarum) elegans*, to which species, therefore,

the English Crag specimens are referred ; and I see no reason why they should not be placed definitely in the genus *Gadus*.

Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2., Vol. XXXI., Plate ii., fig. 13, p. 501, 1871) has figured an otolith from the Antwerp Crag, and referred it to his *Trigloides Dejardinii*, and another said to belong to the recent *Trigla gurnardus* (given as *hirundo* in description of plates). Neither of these specimens has anything to do with the genus *Trigla*, all the species of which have otoliths quite unlike these figures. There has evidently been some slip in the determination of the recent specimen, as already noticed by Herr E. Koken (loc. cit.). Both these otoliths are Gadoid, and that from the Antwerp Crag agrees with the specimens from the Suffolk Crags, which are now referred to *Gadus elegans*.

Genus ARIUS, C. & V.

PLATE X., FIG. 17.

Mr. E. C. Moor of Great Bealings has a fragment of a pectoral spine of a large Siluroid fish, from the Red Crag Nodule-bed, Foxhall, which probably belongs to *Arius (Silurus) Egertoni*, an Eocene form ; and the specimen has most likely been derived from beds of that age.

Genus BARBUS, Cuvier.

BARBUS VULGARIS ? FLEMING.

(*Barbel.*)

(Vert. Forest Bed, p. 134, PLATE XVIII., FIGS. 11-14.)

Some pharyngeal teeth and bones from the Forest-bed at West Runton have been, with some doubt, referred to this species.

Genus LEUCISCUS, Cuvier.

LEUCISCUS RUTILIS, LINNÆUS.

(*Roach.*)

(Vert. Forest Bed, p. 125, PLATE XVIII., FIG. 17.)

Several pharyngeal bones and numerous teeth from the Forest-bed at West Runton have been referred to this species.

The species is now living in Europe north of the Alps.

LEUCISCUS CEPHALUS? LINNÆUS.

(Chub.)

A pharyngeal bone with two teeth, from Ostend, in the Green Collection, and said to be from the Forest-bed, has been referred to this species (Vert. Forest Bed, p. 124, 1882).

The Chub is now living in Europe and Asia Minor.

LEUCISCUS ERYTHROPHTHALMUS, LINNÆUS.

(Rudd.)

(Vert. Forest Bed, p. 126, PLATE XVIII., FIG. 18.)

Certain pharyngeal teeth from the Forest-bed of West Runton have been referred to this species.

The Rudd is now living in Europe and Asia Minor.

Genus TINCA, Cuvier.**TINCA VULGARIS, CUVIER.**

(Tench.)

(Vert. Forest Bed, p. 127, PLATE XVIII., FIGS. 21-23.)

Several pharyngeal teeth from the Forest-bed of West Runton have been referred to this species.

The Tench is now living in Europe.

Genus ABRAMIS, Cuvier.**ABRAMIS BRAAMA, LINNÆUS.**

(Bream.)

(Vert. Forest Bed, p. 126, PLATE XVIII., FIGS. 18, 19.)

Two teeth from the Forest-bed of West Runton, have been thought to belong to this species.

The Bream is now living in Europe north of the Alps and Pyrenees.

Genus **ESOX**, Linnæus.**ESOX LUCIUS LINNÆUS.**

(Pike.)

(Vert. Forest Bed, p. 123, PLATE XVIII., FIGS. 11-14.)

The occurrence of remains of the Pike in the Norwich Crag was noticed by Messrs. R. and A. Bell in 1872. (Proc. Geol. Assoc., Vol. II., p. 212) and by Mr. H. B. Woodward in 1881. (Geology of Norwich, p. 54), but I have not been able to corroborate these records.

The presence of the species in the Forest-bed of several localities was noticed in 1882. The Pike has also been recorded from the Pleistocene and is now living in Europe, Northern Asia, and the northern part of North America.

TELEOSTEAN FISH ; genus undetermined.

There is in the Museum of Practical Geology the vertebral column of a teleostean fish from the Coralline Crag of Sudbourn, Orford, presented by Col. Alexander. The specimen also shows part of the pectoral arch with the fin, and just above this a strongly developed spine, apparently either opercular or clavicular. I have been unable, at present, to identify these remains, but the spine seems to suggest an affinity with such a form as *Cottus scorpius* or one of the Weavers.

GANOIDEI.

Genus PYCNODUS, Agassiz.

The Museum at Ipswich possesses a specimen from the Red Crag Nodule-bed of Suffolk, belonging to the genus *Pycnodus*; but in all probability derived from beds of an earlier period.

Genus GYRODUS, Agassiz.

The Ipswich Museum also has a specimen referable to *Gyrodus* from the Red Crag Nodule-bed of Suffolk, but doubtless it has been derived from older beds.

Genus PISODUS, Owen.

A specimen referable to *Pisodus* has been found in the Nodule-bed of the Red Crag and is preserved in the Ipswich Museum; but has no doubt been derived from a Lower Eocene deposit.

Genus LEPIDOTUS, Agassiz.

(SPHÆRODUS, Agassiz.)

In the Ipswich and York Museums there are some large round teeth from the Nodule-bed of the Suffolk Red Crag precisely similar to those of *Lepidotus maximus* (= *Sphærodus gigas*) and are doubtless to be referred to that genus, and possibly to the same species, having probably been derived from secondary strata. These teeth, however, are likewise very similar to those of the specimen from the Pliocene of Volterrano, referred by Lawley to *Sphærodus cinctus*, Ag. (Atti Soc. Tosc. Sci. Nat. Pisa, Vol. II., fasc. 1, p. 60, 1875) and afterwards renamed *Chrysophrys Lawleyi* by Gervais (Journ. Zoologie, Vol. IV., p. 516, 1875). The latter determination has since been called in question by Dr. Forsyth Major. (Atti Soc. Tosc. Sci. Nat. Pisa, Vol. IV., p. 111, 1879.)

Genus ACIPENSER, Linnæus.

Dermal plates of the Sturgeon from Mundesley and Sidestrand were recorded as Forest-bed fossils in the Survey Memoir (Vert. Forest Bed, p. 129, 1882), and Mr. Savin has since found another example at East Runton. Mr. Smith Woodward (Proc. Geol. Assoc., Vol. XI., p. 29, 1889) has recognised a fin ray of this genus, from the Red Crag Nodule-bed of Suffolk, in the Reed Collection, York Museum; and it has also been recorded by Mr. H. B. Woodward (Geology of Norwich, p. 54, 1881) from the Norwich Crag of Bramerton.

CHIMÆROIDEI.

CHIMÆROIDEI

Genus EDAPHODON, Buckland.

Dentary plates of Chimæroid fishes are not uncommon in the Red Crag Nodule-bed of Suffolk, and although most of them are too fragmentary for definite determination there is no doubt as to many of them belonging to the genus *Edaphodon*. Numerous examples are to be seen in the Museum of Practical Geology and in the Ipswich Museum, all the specimens being much rolled and probably derived from earlier Tertiary beds; the latter fact no doubt accounts for the absence of this genus from previous lists of Crag fossils.

Genus ELASMODUS, Egerton.

ELASMODUS HUNTERI, EGERTON.

This genus and species was established by Sir Philip Grey Egerton (Proc. Geol. Soc., Vol. IV., p. 156, 1843, and Mem. Geol. Surv., Decade VI., Plate i., 1852) for some Chimæroid jaws from the London Clay, in which the dental plates are laminated and scroll-like. One of the lower dentary plates of this species has been met with in the Red Crag Nodule-bed, near Woodbridge, and is preserved in the Museum of Practical Geology; it is probable, however, that this specimen has been derived from Eocene beds. Dr. Fritz Noetling (Fauna Samländ. Tert., Abhandl. geol. Spezialkarte Preus., Vol. VI., 1885) has met with this species in the Miocene (Bernstein formation) of Samland, East Prussia.

Genus CÆLORHYNCHUS, Agassiz.

A fragment of a spine from the Red Crag Nodule-bed of Woodbridge, in the British Museum (No. 43,312), agrees with those from the Eocene to which the name of *Cælorhynchus rectus* has been applied, and probably the specimen has been derived from beds of that age.

In accordance with the suggestion of Mr. Smith Woodward (Ann. Mag. Nat. Hist. Ser. 6, Vol. II., p. 223, 1888) *Cælorhynchus* is here provisionally placed with the Chimæroids.

ELASMOBRANCHII.

Genus GALEUS, Cuvier.

GALEUS CANIS, BONAPARTE.

(*Tope.*)

PLATE IX., FIG. 9.

A single tooth served to indicate the presence of this species in the Weybourn Crag of East Runton, and was noticed in the Survey Memoir (Vert. Forest Bed, p. 130, Plate xix., Fig. 7, 1882). Since then two other examples of these characteristic teeth have been found by Mr. A. Savin in the same beds; and the late Robert Bell recognised an isolated tooth in the Pliocene deposit at St. Erth, Cornwall (Plate IX., Fig. 9).

Mr. E. C. Moor has two teeth from the Red Crag Nodule-bed, Little Bealings, near Woodbridge, referable to this genus but probably not to this species (Plate IX., Figs. 10a, b).

Galeus canis is now living in temperate and tropical seas.

Genus CETORHINUS, Blainville.

(*SELACHE*, Cuvier.)

CETORHINUS MAXIMUS, LINNÆUS.

(*Basking Shark.*)

PLATE IX., FIGS. 12a, b.

Some remarkable claw-like bodies, long known from the Nodule-bed of the Red Crag, were recognised by Prof. Flower as agreeing with the clasper-spines of the Basking Shark (*Cetorhinus maximus*); but the first notice of them seems to have been published by Prof. Van Beneden (Bull. Ac. Roy. Belg., Vol. XLII., p. 296, 1876), who says "En parcourant les galeries du British Museum au mois du Mai dernier, le professeur Flower me fit remarquer, en passant devant le superbe mâle de *Selache*, que le docteur Günther venait de faire mettre en place, les organes appendiculaire avec leur éperons; M. Flower me demanda si nous n'avions pas ces organes à l'état fossile à Anvers, puisqu'on en possédait au Muséum qui provenaient du crag d'Angleterre. C'étaient précisément nos corps problématique d'Anvers qui nous avaient intrigué depuis plusieurs années."

Prof. Van Beneden in 1871 (Bull. Ac. Roy. Belg., Ser. 2, Vol. XXXI., p. 504) noticed certain peculiar spinous bodies in the

Antwerp Crag which he named *Hannovera aurata*; and in 1873 Prof. Steenstrup (K. D. Vidensk. Selsk. Forhandl., No. 1) showed that these bodies agreed with the branchial appendages of the Basking Shark. Afterwards Prof. Van Beneden (Bull. Ac. Roy. Belg., Ser. 2, Vol. XLII., p. 294, 1876) referred them to the genus *Selache*.

It seems highly probable that these specimens, and also the vertebræ from the Antwerp Crag described by M. C. Hasse (Natürl. Syst. Elasmobr. Besond. Theil, p. 241, 1882) belong to the same species as the clasper-spines found in the English Crag, and might be included in the recent species until they can be shown to be distinct.

The Basking Shark is now living in the Arctic Seas, and occasionally comes as far south as Portugal (Günther, Cat. Fishes, B. M., Vol. VIII., p. 394, 1870).

Genus CARCHARODON, Müller & Henle.

Many teeth belonging to this genus have been exhumed from the various Crag pits of Suffolk; but while there has been a general agreement as to the generic affinities of these fossils, the specific determinations have not been so satisfactorily settled. It has long been felt that several of the fossil species named by Agassiz would be found to be parts of the same species, and the memoir by M. R. Lawley (Studi Comp. Pesci, *Carcharodon*, &c., 1881) has helped in this correlation.* At present only two species of *Carcharodon* can be recognised in the British Crags; and this agrees with Lawley's recognition of the same two forms in the Italian Pliocene deposits.

CARCHARODON MEGALODON, AGASSIZ.

PLATE IX., FIGS. 13a, b.

The present species was proposed by Agassiz for the large shark's teeth from the Miocene of Malta, and North America, and similar specimens from the English Crag were referred to the same species. The occurrence of *C. megalodon* in the Crag was first recorded by Mr. Charlesworth (Mag. Nat. His., Ser. 2, Vol. I., p. 225, 1837); subsequently the species was described by Agassiz (Poiss. Foss., Vol. III., p. 247, 1843). The Maltese and American specimens have strongly serrated edges, but the English ones are usually devoid of serrations, and this has led to the supposition that the latter represented a distinct form of Shark. The English Crag examples are, however, always much water-worn, and although it is very rare to find specimens which shows traces of the serration, yet there are one or two such in the Museum of Practical Geology, and there is every reason for thinking, that all these large Shark's

* For full synonymy, reference should be made to Mr. A. Smith Woodward (Cat. Foss. Fishes, B. M., Part i, p. 411 and onwards, 1889.)

teeth were similarly serrated when perfect. One or two teeth from the Red Crag Nodule-bed of Woodbridge and Felixstow, contained in the same Museum, are more elongated and approach the form of *C. angustidens*, Ag. (Poiss. Foss., Vol. III., pl. 28, f. 20). *Carcharodon megalodon* has been recorded from the Nodule-bed below the Coralline Crag at Sutton by Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 118. and 132, 1871) but most of the specimens have been found in the Nodule-bed below the Red Crag, at various localities throughout Suffolk, and examples are to be seen in all collections from this deposit. The species has been noticed from the Belgian Pliocene by Le Hon (Prélim. Mém. Poiss. Tert. Belg., p. 7, 1871); from the same horizon at Montpellier and in Italy by Gervais (Zool. Pal. Fr. ed. 2, p. 520, pl. 74, 1859) and R. Lawley (Studi Comp. Pesci. p. 35, 1881). Its occurrence in Miocene strata at Malta and in North America has already been alluded to; and if certain of the North American phosphatic deposits are correctly referred to the Eocene, then the species must have existed at that period also.

Large teeth similar to these fossils were dredged by the officers of the "Challenger" expedition from the depths of the Pacific, in a condition leading to the supposition that the species was living at a comparatively recent period.

CARCHARODON RONDELETI, MÜLLER & HENLE.

(*Great Blue Shark.*)

PLATE IX., FIGS. 4a, b.

To this living species are referred the shark's teeth from the Suffolk Crag, which are smaller and proportionately more elongated than those of *C. megalodon*, they have strongly serrated edges when unworn, and are sometimes longitudinally grooved, the largest of them being about one inch and a half in length. Teeth of this character were described by Agassiz (Poiss. Foss., Vol. III., p. 254, pl. 30a, figs. 3-7) and named *C. sulcidens*. R. Lawley has described (Studi. Comp. Pesci, Carcharodon, &c., p. 17, 1881) a number of teeth from the Italian Pliocenes which he demonstrated to be the same as the *C. sulcidens* of Agassiz, but which he named *C. etruscus*, and it is not easy to understand why the new name was given. Lawley also noticed the close agreement between his Italian Pliocene specimens and the recent *C. Rondeleti*, but hesitated to refer them to the living form. I see no reason for thinking that *C. sulcidens*, and *C. etruscus*, are specifically distinct from *C. Rondeleti*, and have for some time regarded them as the same species; and this view is taken by Mr. A. Smith Woodward (Cat. Foss. Fishes, B. M., Part i, p. 420, 1889).

Teeth of *Carcharodon Rondeleti* are to be seen in most collections of English Crag fossils, but comparatively few show the serrated edge. The British Museum has a well preserved

specimen from the true Coralline Crag of Orford, Suffolk; but the Nodule-bed below the Suffolk Red Crag has yielded by far the greater number of the English specimens. Under its different synonyms it has been recorded from the Pliocenes of Belgium by Le Hon (Prélim. Mém. Poiss. Tert. Belg., p. 7, 1881) from the same horizon of several localities in Italy by Lawley, (*loc. cit.*) who also identified the species in European Miocene strata; and its occurrence in North America in the Miocene and Eocene has been recorded by R. W. Gibbes (Fossil Squalidae of the United States, 1848). The British Museum has specimens referred to this species from Older Miocene (?), New Zealand, and from the newer Tertiary of Coquimbo, Chili.

At the present day, according to Dr. A. Günther (Cat. Fishes, B. M., Vol. VIII., p. 392), *C. Rondeleti* is found living from the Mediterranean to Australia.

Genus LAMNA, Cuvier.

(OTODUS, Agassiz et auctorum.)

The recent revision of the Elasmobranchii by Mr. A. Smith Woodward (Cat. Foss. Fishes, B. M., Part i, p. 349, 1889), however necessary and desirable, is extremely perplexing and for some time will lead to much confusion, for not only has it necessitated the removal of nearly all the species hitherto known as *Lamna* to the genus *Odontaspis*, but also the placing of all the species of *Otodus* under the generic name of *Lamna*.

Thus revised, the occurrence of *Lamna* (*Otodus*) has been recorded by Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., pp. 132, 349, 1871) from the Nodule-bed below the Coralline Crag and from that below the Red Crag also.

LAMNA (OTODUS) OBLIQUA, AGASSIZ.

Specimens from the London Clay were named *Otodus obliquus* by Agassiz (Poiss. Foss., Vol. III., p. 267) and similar specimens have been found in the Nodule-bed below the Red Crag; but as it is probable that they have been to a large extent, if not wholly, derived from beds older than the Red Crag, the species seems never to have been included in any list of English Crag fossils.

Examples of both large and small teeth agreeing with Agassiz' figures (*loc. cit.*, pl. 31 and pl. 36, figs. 22-27) have been found in the Suffolk Red Crag, and some of each seem too perfect to have been derived from Eocene strata, although there is no doubt as to their belonging to this London Clay species.

Genus OXYRHINA, Agassiz.

OXYRHINA HASTALIS, AGASSIZ.

(Including *O. xiphodon*.)

PLATE IX., FIGS. 15a, b.

Among the shark's teeth from the Suffolk Crag, a number may be found of a broadly triangular and flattened form which, although retaining the cutting edge almost unworn, show no signs of any serration like that found in *Carcharodon*, and are destitute of lateral denticles. Such teeth are referred to the genus *Oxyrhina* and have usually been called *O. xiphodon*, Agassiz (Poiss. Foss. Vol. III., p. 278); other of these teeth have narrower but thicker crowns and agree with those named *O. hastalis* by Agassiz (*loc. cit.*, p. 277).

A large series of teeth found associated in the Pliocene of Tuscany, and described by R. Lawley (*Studi Comp. Pesci, &c.*, 1881, p. 93) under the name of *O. Agassizi*, show the wide variation which may occur in the teeth of one pair of jaws, and has led Mr. Smith Woodward (*Cat. Foss. Fishes, B. M.*, p. 385, 1889) to associate under the name of *O. hastalis*, several species, including the three above mentioned. The forms figured by Lawley as *O. Agassizi* differ somewhat from those found in the Crag with which I am familiar.

Messrs. R. and A. Bell (*Proc. Geol. Assoc.*, Vol. ii., p. 202) recorded *O. xiphodon* from the true Coralline Crag of Suffolk and there are three specimens referred to the present species in the British Museum from the same horizon; but by far the larger number of English specimens are from the Nodule-bed below the Red Crag of Suffolk.

This species is also recorded in the British Museum Catalogue from Pliocene beds at Antwerp, Montpellier, and Tuscany; also from Miocene beds in Belgium, France, Spain, Portugal, Switzerland, Würtemberg, Malta, Italy, Sicily, Corsica, and possibly Melbourne. It has also been found in the Oamaru system, New Zealand; in Tertiary beds in the Canary and Cape de Verde Isles; and in Miocene and Lower Tertiary beds in North America.

Genus ODONTASPIS, Agassiz.

(LAMNA, Agassiz et auctorum.)

Allusion has already been made (p. 105) to the revision which has necessitated the removal of most of the species of *Lamna* to *Odontaspis* and the use of the name *Lamna* for all those species which have been called *Otodus*; attention is again directed to this to prevent any misunderstanding as to the forms here noticed.

Agassiz recognised among the English Crag fossils *Odontaspis* (*Lamna*) *elegans*, *contortidens*, and *Hopei* (Poiss. Foss., Vol. III.,

pp. 290, 293, 295), but believed them to be *remanié*, and this no doubt is the reason they have never been included in any published lists of crag fossils.

The occurrence of this genus in the Coralline and Red Crags was noted by Prof. Prestwich, (Quart. Journ. Geol., Vol. XVII., pp. 118 and 349, 1871).

ODONTASPIS (LAMNA) ELEGANS, AGASSIZ.

PLATE IX., FIGS 16a, b.

Lamna elegans was the name given by Agassiz (Poiss. Foss., Vol. III., p. 289, 1843) to teeth from the Calcaire Grossier and London Clay, examples being noticed as *remanié* in the English Crag. Numerous examples from the Red Crag Nodule-bed of Suffolk are in the Museum of Practical Geology; some of which are probably derived from older beds, being much rolled and worn; but many of them are beautifully perfect with the cutting edge quite sharp, and these it is thought must be of Red Crag age.

O. elegans has a wide range in time, having been met with at various horizons from the Chalk of Maestricht to the Oligocene of Belgium (*vide* Rutot, Ann. Soc. Géol. Belg. Vol. II., p. 34, 1875), and the specimens above noticed show that it extended at least as far as the Nodule-bed of the Red Crag of Suffolk.

ODONTASPIS (LAMNA) CONTORTIDENS, AGASSIZ.

PLATE IX., FIGS. 17a, b.

This species, which was established by Agassiz (Poiss. Foss., Vol. III., P. 294), and recognised by him in the English Crag, is represented in the Museum of Practical Geology by several teeth from the Nodule-bed of the Red Crag, most of which are rolled and denuded, but some are perfect with the edges and striations so sharp, they could scarcely have been derived from any older formation; and although *O. contortidens* is essentially a Lower Eocene form, it seems to me that some of our specimens from the Suffolk Crag must have lived at the time when this bed was being deposited.

At present I have been unable to detect any specimens which could be undoubtedly referred to *O. Hopei*, although this species was mentioned by Agassiz as occurring in the Crag. Denuded specimens of *O. contortidens*, having lost their striations, would appear like *O. Hopei*.

Genus *NOTIDANUS*, Cuvier.

The occurrence of the genus *Notidanus* in the English Crag seems to have been first recorded by Mr. H. B. Woodward in the Survey Memoir (Geology of Norwich, p. 54, 1882), who noted a specimen from the Norwich Crag of Thorpe, in the collection of Mr. R. Fitch. The small size of the specimen unfortunately led to its being named *N. microdon*; but a closer examination, recently made, leads me to think that my former determination was incorrect, and that it cannot be referred to the Cretaceous species; possibly it may be a small example of the form now to be noticed.

NOTIDANUS GIGAS, SISMONDA.

PLATE IX., FIG. 18.

When Mr. A. Smith Woodward (Geol. Mag., Dec. 3., Vol. III., p. 205, 1886) published his revision of the genus *Notidanus* he noted three species as occurring in the English Crag, *N. primigenius*, *N. gigas*, and *N. Meneghini*. I suggested at the time that there was not sufficient grounds for separating the two species last named, and in my MS. prepared for the present memoir I wrote:—

“With regard to *Notidanus Meneghini*, Lawley, I fail to see any good reason for making it distinct from *N. gigas*, Linn. A comparison of the figures given by Sismonda of *N. gigas* (Mem. R. Acc. Sci. Torino, Ser. 2, Vol. XIX., p. 460, Fig. 13), by Lawley of the same species and of *N. Meneghini* (Atti Soc. Toscana, Vol. III., Plate i, Fig. 6, and Plate ii, Fig. 4), and by Smith Woodward of these same species (Geol. Mag., Dec. 3, Vol. III., pp. 255, 256), seems to show smaller differences between them than have been accepted as variations of *N. primigenius* (compare also Agassiz, Poiss. Foss., Vol. III., Plate 27, Fig. 16, Lawley, *loc. cit.* Plate i, Fig. 1, Smith Woodward, *loc. cit.* Plate vi, Fig. 22). Such being the case *N. Meneghini* is regarded as a synonym of *N. gigas*; indeed, it seems not improbable that both these species may eventually prove to be varieties of Agassiz’s *N. primigenius*.”

I am glad to find that Mr. Smith Woodward (Cat. Foss. Fishes, B. M., Part i, pp. 164, 165) is now practically of the same opinion, for he only acknowledges one species in the English Crags, *N. gigas*, and keeps the name of *N. primigenius* for the Eocene forms.

Notidanus gigas has been found in the Nodule-bed of the Red Crag at Woodbridge, Butley, Felixstow, and other localities in Suffolk; and examples are to be seen in the British Museum, and Museum of Practical Geology, as well as in the Museums at York and Ipswich. The species likewise occurs in the Pliocene of Tuscany.

Genus **MYLIOBATIS**, Cuvier.

Dental plates belonging to this and allied genera are not uncommon in the Nodule-bed of the Red Crag; but as they are mostly isolated and broken, it is not possible to say to which genus they belong. Seeing, however, that undoubted examples of *Myliobatis* and *Aetobatis* occur in this deposit, it is better to regard these fragments as parts of one or other of these forms. It is highly probable that the specimens from the Coralline and Red Crags referred to by Prof. Prestwich (Quart. Journ. Geol. Soc., Vol. XXVII., p. 132, 1871) and Messrs. R. and A. Bell (Proc. Geol. Assoc., Vol. II., p. 202, 208, 1872) as *Zygodatis Woodwardi* are of this nature. I have been unable to find any specimens from these deposits which could be certainly called *Zygodatis*, and provisionally retain the name of *Zygodatis (Rhinoptera) Woodwardi* only for the very doubtful specimens recorded by Agassiz from the Norwich Crag.

Many of the specimens are no doubt derived from the Eocene.

MYLIOBATIS DIXONI, AGASSIZ.

A portion of a palate in the Museum of Practical Geology from the Red Crag Nodule-bed of Boyton, including parts of four dental elements, which are proportionately wide and convex, and another specimen from the same horizon in the Ipswich Museum, are believed to belong to Agassiz' (Poiss. Foss., Vol. III., p. 319), Eocene species, *M. Dixonii*, and probably have been derived from beds of that age.

MYLIOBATIS TOLIAPICA, AGASSIZ.

This species, which was established by Agassiz (Poiss. Foss. Vol. III., p. 321) for a London Clay species, is represented in the Nodule-bed of the Red Crag, by a specimen in the Museum of Practical Geology, from near Woodbridge, which agrees with the example figured by Dixon (Geol. Sussex, Plate x, Fig. 5), it has six median plates and a double row of laterals on one side. This specimen having been ground down some distance below the natural surface, has the edges of the plates serrated, and thus resembles the *M. suturalis*, Agassiz (Poiss. Foss., Vol. III., Plate 46, Fig. 12) now included under the above species (Cat. Foss. Fishes, B. M., p. 116). There is another specimen in the same Museum from Waldringfield, and a third in the Ipswich Museum from the same horizon. All these specimens have probably been derived from Eocene strata.

MYLIOBATIS (?) TUMIDENS, S. WOODWARD.

Mr. Smith Woodward (Cat. Foss. Fishes, Brit. Mus., Part i, p. 119, 1890) has given the name *M. tumidens* to some median dental plates from the Red Crag Nodule-bed preserved in the British Museum; but it is not quite certain that they belong to this genus, the ends being abraded. "The coronal contour is sharply raised in the middle, as in *M. jugosus*, Leidy, differing only from the latter tooth in the greater relative breadth of the rounded elevation."

Genus *ÆTOBATIS*, Müller & Henle.

Elongated dental plates, having the ends curved down, and thus showing unmistakably that there were no lateral denticles, are referred to *Ætobatis*. Such plates have been found in the Nodule-bed below the Red Crag at Waldringfield, Woodbridge, and elsewhere in Suffolk, and are to be seen in the Museum of Practical Geology, the British Museum, and other collections of Crag fossils. They have doubtless been derived from the Eocene.

Genus RHINOPTERA, Müller & Henle.

(*ZYGOBATIS*, Agassiz.)

RHINOPTERA WOODWARDI, AGASSIZ.

Agassiz (Poiss. Foss., Vol. III., p. 329) proposed the name of *Zygobatis Woodwardi* provisionally for a number of isolated dental plates, from the Norfolk Crag, in the collections of Messrs. Buxton and Woodward which he thought more likely to belong to this genus than to *Myliobatis*. Since then all dentary plates of Batidæ found in the Crags have been put under the name *Zygobatis Woodwardi*, which has been said to occur in the Coralline, Red and Norwich Crags. Reasons have already been given for thinking that none of the plates from the Coralline and Red Crags can be referred to this genus and species, and for the present it is retained for the Norwich Crag dental plates described by Agassiz, which seem to be extremely rare, the few fragments in the British Museum (P. 1524) being the only examples with which I am acquainted, and these are far from being satisfactory.

Genus PTYCHODUS, Agassiz.

PTYCHODUS POLYGYREUS, AGASSIZ.

Fragments of *Ptychodus* teeth from the Nodule-bed below the Red Crag of Suffolk are preserved in the Ipswich Museum. These have doubtless been derived from the Chalk, and are interesting an account of the rarity of Cretaceous *remanié* fossils in these deposits.

Genus RAJA, Linnæus.

RAJA CLAVATA, LINNÆUS.

(Thornback.)

(Vert. Forest Bed, p. 132, PLATE XIX., FIGS. 10, 11.)

Teeth agreeing with those of the living "Thornback" have been recorded from the Weybourn Crag of East Runton (Mem. Geol. Surv. Vert. Forest Bed., p. 132, 1882) and are preserved in the Museum of Practical Geology and in Mr. Savin's collection at Cromer. Agassiz (Poiss. Foss., Vol. III., p. 371) proposed the name of *R. antiqua*, for dermal defences of Rays found in the Norwich Crag, which agree precisely with those of the living *R. clavata*, he, apparently, thinking it impossible for the Crag species to be still living. These Crag dermal defences are now included with the teeth above noticed in the recent species *R. clavata*. Dermal defences referable to *Raja clavata* have been found in the true Coralline Crag of Orford and Gedgrave, in the Nodule-bed below the Red Crag at numerous localities in Suffolk, and in the Norwich Crag at several places in Norfolk. They have also been recorded from the Antwerp Crag and from the Pliocene of Tuscany.

Teeth of this species have, at present, only been found in the Weybourn Crag of East Runton.

Now living on the coasts of Europe.

RAJA BATIS, LINNÆUS.

(Skate.)

(Vert. Forest Bed, p. 131, PLATE XIX., FIG. 9.)

A number of teeth of this species have been found in the Weybourn Crag at East Runton, and like the last are now in Mr. Savin's collection, and in the Museum of Practical Geology. In the latter there is also a similar tooth obtained by Mr. Clement Reid from the Coralline Crag of Gedgrave. Mr. Lamplugh also has teeth of the same species from the so-called "Bridlington Crag."

Now living on the coasts of Europe.

RAJA, sp.

PLATE IX., FIGS. 21a, b.

Two fish defences in the Museum of Practical Geology evidently of the same nature as those of *R. clavata*, but differing in character, are provisionally referred to this genus. One of them is from the Nodule-bed of the Red Crag at Boyton, and the other is from the Coralline Crag of Gedgrave, the latter being the one now to be described. The basal plate is irregular in form, with the margin folded and crenulated; rising gradually towards the middle it becomes smooth and then forms a strong curved denticle, which is placed towards the broader end of the plate. There is no central depression or concentric lines on the upper surface as in most of the defences of *R. clavata*, and the under portion is hollowed, the cavity extending into the denticle.

The defences of *Raja radiata* somewhat resemble this fossil, but they are more star-like, the radial ridges being strongest towards the centre.

It may be that these Crag defences do not really belong to *Raja*, but to some species of *Trygon*; I have not, however, been successful in identifying them definitely, and therefore prefer not to introduce another genus without better evidence.

Genus PRISTIS, Latham.

Portions of rostral teeth of *Pristis* from the Red Crag Nodule-bed of Woodbridge are in the British Museum, but have probably been derived from beds of Eocene age.

Genus SQUATINA, Duméril.

PLATE IX., FIGS. 11a, b, c.

There is in the British Museum a small tooth from the Red Crag Nodule-bed of Suffolk which Mr. A. Smith Woodward (Cat. Foss. Fishes, B. M., Part i, p. 71, 1889) has referred to this genus, but without any specific determination. Mr. E. C. Moor possesses a similar tooth from the same horizon at Little Bealings, near Woodbridge, and there is a third in the York Museum. These teeth have an acute median cusp on a wide basal portion and are without lateral denticles; but there is a downwardly directed median process of the shining crown on the outside, and a horizontally directed portion on the inside. The root of the tooth forms a plate almost at right angles to the cusp, and on its underside is a depression in which is the vascular foramen.

These teeth agree so nearly with those of the recent *Squatina angelus*, that one would scarcely have hesitated to place them in that species, were it not that similar teeth are known from Lower Eocene beds (Cat. Foss. Fishes, B. M., Part i, page 71) and also from the Chalk; and seeing that the Cretaceous forms, or at least some of them, have been shown to belong to another species, *S. Craniæ*, by Mr. Smith Woodward (Quart. Journ. Geol. Soc. Vol. XLII, p. 144, 1888), it is perhaps better for the present to leave the species of the Crag form uncertain.

The teeth described by Dr. J. Probst (Jahresh. Ver. Nat. Württ., Vol. XXXV., p. 177, 1879) as *Squatina alata*, from the Molasse of Baltringen are very similar to ours from the Red Crag; but on the whole seem less like than those of *S. angelus*. It is probable that the Red Crag specimens have been derived from older deposits.

Genus ACANTHIAS, Risso.

ACANTHIAS VULGARIS. RISSO.

(*Piked Dog-fish.*)

(Vert. Forest Bed, p. 131, PLATE XIX., FIG. 8.)

A single tooth referable to this species was found in the Weybourn Crag of East Runton by Mr. Clement Reid, and another example has since been obtained at the same place by Mr. A. Savin.

Acanthias vulgaris is now living in temperate seas of the Northern and Southern Hemispheres.

TABLE
OF
DISTRIBUTION
OF
BRITISH PLIOCENE VERTEBRATA.

N.B. The letter R in the first column signifies the Nodule Bed below the Red Crag, and the letter C the Nodule Bed below the Coralline Crag.

A note of interrogation in the first column immediately after a genus or species signifies doubt as to its occurrence in the British Pliocene.

TABLE OF DISTRIBUTION IN TIME—*continued.*

Name.	Nodule-bed.	Coraline Crag.	Red Crag.	Norwich Crag.	Weybourne Crag.	Forest-bed.	Pleistocene.	Living.	Extinct.	—
UNGULATA.										
<i>Bos</i> or <i>Bison</i> - - - - R x										
<i>Bison bonasus</i> , <i>Linn.</i> - - - -										
<i>Ovibos moschatus</i> , <i>Zimm.</i> - - - -										
<i>Caprovis Savinii</i> , <i>Newton</i> - - - -										
Antilope? - - - - R?										
<i>Gazella anglica</i> , <i>Newton</i> - - - -										
Ruminant, genus undetermined - - - - .. x										
<i>Cervulus dicranoceros</i> , <i>Kaup.</i> - - - -										
<i>Cervus ardeus</i> , <i>Cr. & Job.</i> - - - -										
“ <i>carnutorum</i> , <i>Laugel</i> - - - - x										
“ <i>Dawkinsi</i> , <i>Newton</i> - - - -										
“ <i>elaphus</i> , <i>Linn.</i> - - - -										
“ <i>etueriarum</i> , <i>Cr. & Job.</i> - - - -										
“ <i>Falconeri</i> , <i>Dawkins</i> - - - - R x										
“ <i>Fitchii</i> , <i>Gunn, MS.</i> , <i>Newton</i> - - - -										
“ <i>giganteus</i> ?, <i>Blum.</i> - - R?										
“ <i>polignacus</i> , <i>Robert.</i> - - - -										
“ <i>rectus</i> , <i>Newton</i> - - - -										
“ <i>Savini</i> , <i>Dawkins</i> - - - -										
“ <i>Sedgwickii</i> , <i>Falconer</i> - - - -										
“ <i>suttonensis</i> , <i>Dawkins</i> - - - - R x										
“ <i>tetraceros</i> , <i>Mackie</i> - - - -										
“ <i>verticornis</i> , <i>Dawkins</i> - - - - R x										
<i>Alces latifrons</i> , <i>Johnson</i> - - - -										
<i>Capreolus caprea</i> ?, <i>Gray</i> - - - -										
<i>Xiphodon platyceps</i> , <i>Flower</i> - - - - R										
<i>Hippopotamus amphibius</i> , <i>Linn.</i> - - - -										
<i>Sus antiquus</i> ?, <i>Kaup.</i> - - - - R?										
“ <i>palaeochoerus</i> , <i>Kaup.</i> - - - - R										
“ <i>scrofa</i> , <i>Linn.</i> - - - -										
<i>Equus caballus</i> , <i>Linn.</i> - - - - R?										
“ <i>Stenonis</i> , <i>Cochi</i> - - - -										
<i>Hipparium gracile</i> , <i>Kaup.</i> - - - - R										
<i>Rhinoceros incisivus</i> , <i>Kaup.</i> - - - - R										
“ <i>Schleiermacheri</i> , <i>Kaup.</i> C?R										
“ <i>etruscus</i> , <i>Falconer</i> - - - -										

TABLE OF DISTRIBUTION IN TIME—*continued.*

TABLE OF DISTRIBUTION IN TIME—*continued.*

TABLE OF DISTRIBUTION IN TIME—*continued.*

Name.	Nodule-bed.	Coralline Crag.	Red Crag.	Norwich Crag.	Weybourne Crag.	Forest-bed.	Pleistocene.	Living.	Extinct.	—
CETACEA—cont.										
<i>Mesoplodon angustus, Owen</i>	R	..	..	..	..	..	..	..	..	×
“ <i>angulatus, Owen</i>	R	..	..	..	..	..	..	..	..	×
“ <i>compressus, Huxley</i>	R	..	..	..	..	..	..	..	..	×
“ <i>Floris, Newton</i>	R	..	..	..	..	..	..	..	..	×
“ <i>scaphoides, Newton</i>	R	..	..	..	..	..	..	..	..	— = M. Floweri, Canham, MS., non Von Haast.
Ziphoid remains	..	x	..	..	..	x	..	..	..	..
<i>Squalodon antwerpensis, V. Ben.</i>	R	..	..	..	..	..	..	..	..	×
<i>Orca citoniensis, Capellini</i>	R	..	..	..	..	..	..	..	..	×
“ <i>gladiator, Gray</i>	..	..	..	..	..	x	..	..	..	..
<i>Pseudorca crassidens, Owen</i>	..	..	..	..	..	?	?	..	..	..
<i>Globicephalus uncidens, Lank.</i>	R	x	..	x	..	..	..	..	..	..
<i>Monodon monoceros, Linn.</i>	R?	..	..	..	..	x	x	x	x	..
<i>Delphinapterus leucas, Pallas</i>	..	..	..	..	..	x	x	x	x	..
<i>Delphinus delphis, Linn.</i>	..	..	..	x	..	x	..	x	x	..
<i>Tursiops tursio?, Bonnaterre</i>	..	?	..	..	..	?	..	x	..	..
<i>Phocæna communis, Lesson</i>	..	..	..	..	..	x	..	x	..	..
(Delphinoid petrotympanics, not generically determined.)	R	..	..	..	..	..	..	..	..	..
AVES.										
<i>Bubo ignavus, Forst. (=B. maximus.)</i>	..	..	..	..	..	x	..	x	..	..
<i>Phalacrocorax carbo, Linn.</i>	..	..	..	..	..	x	..	x	..	..
<i>Anser</i>	..	..	..	..	..	x	..	..	..	..
<i>Anas</i>	..	..	..	..	..	x	..	..	..	..
<i>Spatula clypeata, Linn.</i>	..	..	..	..	..	x	..	x	..	..
<i>Uria troile, Linn.</i>	..	..	..	x	..	..	..	x	..	..
<i>Mergulus?</i>	..	..	..	..	?	..	..	..	..	..
<i>Diomedea</i>	..	x	x	..	..	..	x	..	..	..
REPTILIA.										
<i>Chelonia</i>	R	..	..	..	..	..	..	..	..	— ? Derived.
<i>Tropidonotus natrix, Linn.</i>	..	..	..	..	..	x	..	x	..	..
<i>Pelias berus, Linn.</i>	..	..	..	..	..	x	..	x	..	..
AMPHIBIA.										
<i>Rana temporaria, Linn.</i>	..	..	..	..	..	x	..	x	..	..
“ <i>esculenta, Linn.</i>	..	..	..	..	..	x	..	x	..	..
<i>Bufo</i>	..	..	..	..	..	x	..	..	..	..
<i>Triton cristatus, Laur.</i>	..	..	..	..	..	x	..	x	..	..

TABLE OF DISTRIBUTION IN TIME--continued.

Name.	Nodule-bed.	Coralline Crag.	Red Crag.	Norwich Crag.	Weybourne Crag.	Forest-bed.	Pleistocene.	Living.	Extinct.	—
PISCES.										
TELEOSTEI.										
<i>Perca fluviatilis, Linn.</i>	..	..	..	..	..	x	x	x	..	
<i>Acerina vulgaris?, Cuvier.</i>	..	..	..	..	..	?	..	x	..	
<i>Chrysophrys</i>	R	x	..	x	x	..	..	..	..
<i>Platax Woodwardi, Ag.</i>	R	x	x	x	x	x	..	..	x	
<i>Thynnus thynnus, Linn.</i>	..	..	..	..	..	x	..	x	..	
“ <i>scaldiensis, Storm.</i>	..	x	..	..	..	..	..	..	x	
<i>Anarrhichas lupus, Linn.</i>	..	x	..	..	..	..	..	x	..	
<i>Labrus</i>	R	..	..	..	..	..	..	..	..
<i>Phyllodus</i>	R	..	..	..	..	..	..	..	x	Derived.
<i>Pleuronectes</i>	..	..	..	..	..	x	..	..	..
<i>Gadus morrhua, Linn.</i>	..	?	..	x	..	x	..	x	..	
“ <i>pseudæglefinus, Newton.</i>	..	x	x	x	x	..	..	..	x	
“ <i>luscus, Linn.</i>	..	x	x	..	..	..	..	x	..	
“ <i>minutus, Linn.</i>	..	x	..	..	..	..	..	x	..	
“ <i>merlangus, Linn.</i>	..	?	..	..	..	..	..	x	..	Also St. Erth.
“ <i>virens?, Linn.</i>	..	?	..	..	..	..	..	x	..	
“ <i>pollachius, Linn.</i>	..	?	..	x	x	..	..	x	..	
“ <i>elegans, Koken.</i>	..	x	x	..	..	..	..	..	x	Oligocene in Germany. Eocene.
<i>Arius</i>	R	..	..	..	..	..	..	..	..
<i>Barbus vulgaris?, Flem.</i>	..	..	..	..	..	?	..	x	..	
<i>Leuciscus rutilus, Linn.</i>	..	..	..	..	..	x	..	x	..	
“ <i>cephalus?, Linn.</i>	..	..	..	..	..	?	..	x	..	
“ <i>erythrophthalmus, Linn.</i>	..	..	..	..	..	x	..	x	..	
<i>Tinca vulgaris, Cuvier.</i>	..	..	..	..	..	x	..	x	..	
<i>Abramis brama, Cuvier.</i>	..	..	..	..	..	x	..	x	..	
<i>Esox lucius, Linn.</i>	..	..	..	?	..	x	x	x	..	
Teleostean fish, genus?	..	x	..	..	..	..	..	..	..
GANOIDEI.										
<i>Pycnodus</i>	R	..	..	..	..	..	..	..	x	Derived.
<i>Gyrodus</i>	R	..	..	..	..	..	..	..	x	Derived.
<i>Pisodus</i>	R	..	..	..	..	..	..	..	x	Derived.
<i>Lepidotus</i>	R	..	..	..	..	..	..	..	x	Derived.
<i>Acipenser</i>	R	..	..	x	..	x	..	..	..

TABLE OF DISTRIBUTION IN TIME—continued.

Name.	Nodule-bed.	Coraline Crag.	Red Crag.	Norwich Crag.	Weybourne Crag.	Forest-bed.	Pleistocene.	Living.	Extinct.	—
CHIMÆROIDEI.										
Edaphodon	R	..	..	..	..	..	..	..	x	Derived.
Elasmodus Hunteri, <i>Egerton.</i>	R	..	..	..	..	..	..	..	x	Derived.
Cœlorrhynchus	R	..	..	..	..	..	..	..	x	Derived.
ELASMOBRANCHII.										
Galeus canis, <i>Bonaparte</i>	..	..	..	..	x	..	..	x	..	Also St. Erth.
Galeus sp.	R	..	..	..	..	..	..	..	..	..
Cetorhinus maximus, <i>Linn.</i>	R	..	..	..	..	..	..	x	..	..
Carcharodon megalodon, <i>Ag.</i>	C R	..	..	..	..	..	..	..	x	..
“ Rondeleti, <i>M. & H.</i>	R	x	..	..	..	..	..	x	..	..
Lamna (Otodus) obliqua, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Partly derived.
Oxyrhina hastalis, <i>Ag.</i> (including <i>O. xiphodon</i>).	R	x	..	..	..	..	..	..	x	..
Odontaspis elegans, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Partly derived.
“ contortidens, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Partly derived.
Notidanus gigas, <i>Sismonda</i>	R	..	..	..	..	..	..	..	x	..
“ sp.	..	..	..	x	..	..	..	..	..	..
Myliobatis Dixoni, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Derived.
“ toliapica, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Derived.
“ tumidens, <i>S. Woodward.</i>	R	..	..	..	..	..	..	..	x	..
Ætobatis	R	..	..	..	..	..	..	..	..	Derived.
Rhinoptera (Zygotobatis) <i>Woodwardi, Ag.</i>	..	..	..	x	..	..	..	..	x	..
Ptychodus polygyrus, <i>Ag.</i>	R	..	..	..	..	..	..	..	x	Derived.
Raja clavata, <i>Linn.</i>	R	x	x	x	x	..	..	x	..	..
“ batis, <i>Linn.</i>	..	x	..	..	x	..	..	x	..	..
“ sp.	R	x	..	..	..	..	..	..	..	..
Pristis	R	..	..	..	..	..	..	..	..	..
Squatina	R	..	..	..	..	..	..	..	..	Perhaps derived.
Acanthias vulgaris, <i>Risso.</i>	..	..	..	..	x	..	..	x	..	..

SUMMARY.

In the Pliocene strata of Britain 212 distinct species of Vertebrata are known to occur; about 20 of these have evidently been derived from Eocene rocks, and several others have only been generically determined, or the species is somewhat uncertain. After the elimination of these derived and doubtful forms, however, about 142 definite species remain, and it is these only which are made use of in the following summary, although there are about 190 species which may be accepted as constituting the Vertebrata fauna of the British Pliocene deposits as at present known.

The Nodule-bed below the Coralline Crag has rarely been exposed, and consequently has yielded but few vertebrate remains; the specific determination of those which have been found is in most cases uncertain, and the specimens themselves are not accessible.

The Nodule-bed below the Red Crag is the horizon which has been worked for "Coprolites," and from it 68 species of vertebrates have been obtained, six of which are now living, while 62 have become extinct. From the Coralline Crag itself only 15 species are known, five of which are living and 10 extinct. The Red Crag, properly speaking, that is, excluding the Nodule-bed at its base, has yielded very few Vertebrata, only six species being known, and three of these are living forms. The Norwich Crag has given us 21 vertebrate species, of which five are still living. From the Weybourn Crag only seven species are known, and five of these are now living. From the Forest-bed Series of deposits 65 species have been obtained, and 45 of them are still living.

The following Table gives the above statistics in a more accessible form, and at the same time indicates the proportion of the species of Vertebrata which lived in earlier Pliocene times, as well as the numbers of those which lived on to a later period, although now extinct.

	Number of Species.	Occur also in lower beds.	Lived on to a later period.	Living species.	Extinct species.	Per- centage of living forms.
Nodule-bed below the Red Crag	68	—	20	6	62	8·8
Coralline Crag	15	8	8	5	10	—
Red Crag	6	5	5	3	3	—
Norwich Crag	21	10	12	5	16	—
Weybourn Crag	7	5	6	5	2	—
Forest-bed	65	17	47	45	20	69·2

The Vertebrata, on account of their more specialised forms, would be likely to change more rapidly than the Invertebrata, and it might therefore be expected that they would be found to yield data for the more definite division of the Pliocene horizons; but it will be obvious from a glance at the table that the materials available from the beds between the Nodule-bed and the Forest-bed are quite insufficient for this purpose. With regard to these two horizons it is interesting to note the great increase of living species, for while in the former they comprise less than 9 per cent. of the fauna, yet in the latter they have advanced to nearly 70 per cent.

This large proportion of living forms in the Forest-bed is, however, to some extent due to the fishes, amphibia, reptiles, birds, and small mammals being included, few of which have been obtained from other Pliocene or Pleistocene horizons, and when these are eliminated, leaving only the larger mammals, as in the other horizons, about 40 species remain, of which 50 per cent. are now living. About 80 per cent. of the British Pleistocene mammals are still living.

The large number of recent species found in the Forest-bed has been looked upon as a reason for including that series of deposits with the Pleistocene rather than with the Pliocene; this, however, can scarcely be accepted in face of the facts just noticed. Moreover a large proportion of the Deer which were abundant in the Forest-bed times, died out before the deposition of those beds which are generally accepted as of Pleistocene age. And besides this the Forest-bed is linked on to the beds below by several forms which do not pass to the beds above, and although that essentially Pliocene mammal, the Mastodon, is absent from the Forest-bed, yet this does not seem sufficient to outweigh the evidence in favour of placing the Forest-bed in the Pliocene. However, it is not of very great moment whether these deposits are classed with the series just above or those below them; and happily there is a general agreement that the Forest-bed stands between strata of undoubted Pliocene and Pleistocene age.

In all the Pliocene deposits there is a mingling of what appear to be northern and southern animals. The land mammals of the Nodule-bed include such sub-tropical genera as *Hyæna*, *Antelope*, *Tapir*, *Rhinoceros*, *Elephant*, and *Mastodon*; but with these are a few which seem to indicate more temperate conditions, and the Marine mammals may point to a still colder climate, for some of the Cetacea are such as now inhabit the more northern parts of this hemisphere. The fishes of the Nodule-bed again point to a warmer climate.

From the Coralline Crag Cetacean remains have been obtained which seem to indicate a temperate climate, and the large number of fish Otoliths from this horizon all belong to Gadoids which are common in temperate and northern seas, but are rare so far south as the Mediterranean. *Chrysophrys*, *Thynnus*, and *Platax*, on the other hand, may indicate warmer conditions.

The Forest-bed Vertebrata generally are temperate forms, but with them are found such northern animals as the Glutton, Musk Ox, Walrus, and Narwhal, as well as such southern genera as *Hyæna*, *Hippopotamus*, *Rhinoceros*, *Elephant*, and *Tunny*.

It seems from a consideration of the Pliocene Vertebrata that the climate of England in the earlier part of that period was decidedly warmer than it is at the present day, and approached sub-tropical conditions; and that, notwithstanding minor variations which may have subsequently taken place, the general tendency was to become colder, so that in the Forest-bed times the climate was temperate, with, possibly, periods of greater heat and still greater cold, perhaps partly due to continental conditions, which at length culminated in the Glacial or Pleistocene Epoch. The earliest Pleistocene deposit recognised being the "Arctic Freshwater Bed" of Norfolk, which is characterized by an assemblage of Arctic plants, and a *Spermophilus*, and occurs immediately below the Boulder Clay.

The relations which the English Crags and Forest-bed bear to the Pliocene strata of the continent of Europe are fully treated of by my colleague Mr. Clement Reid in his Survey Memoir on the "Pliocene Deposits of Britain," 1890.

LIST OF WORKS
 WHICH MAY BE CONSULTED RELATIVE TO
 BRITISH PLIOCENE VERTEBRATA.

SUPPLEMENTARY TO THAT GIVEN IN THE FOREST BED MEMOIR. See p. 3.

AGASSIZ, L.—*Récherches sur les Poissons Fossiles*, 1833-43.

BACKHOUSE, J.—On a Mandible of *Machærodus* from the Forest-Bed. *Quart. Journ. Geol. Soc.*, vol. xlii., p. 309, 1886.

BENEDEN, P. J. VAN.—Sur des ossements fossiles trouvés dans les environs de Saint Nicholas. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. x., p. 403, 1860.

Récherches sur les ossements provenant du Crag d'Anvers. Les Squalodons. *Mém. Ac. Roy. Belg.*, vol. xxxv., part. 3, 1865.

Récherches sur les Squalodons. Supplement. *Ibid.*, vol. xxxvii., Part. v., 1869.

Récherches sur quelques poissons fossiles de Belgique. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xxxi., p. 493, 1871.

Les Oiseaux de L'Argile Rupellienne et du Crag. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xxxii., p. 213, 1871.

Les Baleines fossiles d'Anvers. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xxxiv., p. 6, 1872.

Les ossements fossiles du genre *Aulocète* au Musée de Linz. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xl., p. 536, 1875.

Les Thalassothériens de Baltringen. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xli., p. 471, 1876.

Les Phoques fossiles du bassin d'Anvers, *Ibid.* p. 783, 1876.

Un Mot sur le Selache (Hannovera) aurata, du crag d'Anvers. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xlii., p. 294, 1876.

Note sur un Cachalot nain du crag d'Anvers. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. xliv., p. 851, 1877.

Les Mysticètes à courts fanons des sables des environs d'Anvers. *Bull. Ac. Roy. Belg.*, Ser. 2, vol. 50, p. 11, 1880.

Sur un poisson fossile nouveau des environs de Bruxelles et sur certain corps énigmatique du crag d'Anvers. *Bull. Ac. Roy. Belg.*, Ser. 3, vol. i., p. 116, 1881.

Description des Ossements Fossiles des environs d'Anvers. *Part 1, Ann. Mus. Roy. His. Nat. Belg.*, vol. i., 1877. *Part 2, ibid.*, vol. iv., 1880. *Part 3, ibid.*, vol. vii., 1882. *Part 4, ibid.*, vol. ix., 1885.

BENEDEN, VAN and PAUL GERVAIS.—*Ostéographie des Cétacés*, 1880.

CAPELLINI, G.—Sulla scoperta di un gruppo di vertebre di vera Balena nella sabbie gialle compatte plioceniche dei dintorni di Chiusi. *Mem. Acc. Sci. Inst. Bologna*, Ser. 3, vol. iii., p. 1, 1873.

Della Pietra Leccese e di Alcuni suoi Fossili. *Mem. Acc. Sci. Inst.*, Bologna, Ser. 3, vol. ix., p. 227, 1878.

Avanzi di Squalodonte nella Mollassa, Marnosa, Miocenica del Bolognese. *Mem. Acc. Sci. Inst.*, Bologna, Ser. 4, vol. ii., p. 413, 1881.

CAPELLINI, G.—Di un' Orca fossile scoperta a Cetona in Toscana. *Mem. Acc. Sci. Inst., Bologna, Ser. 4, vol. iv.*, p. 665, 1883.

Resti Fossili di Dioplodon e Mesoplodon. *Mem. Acc. Sci. Inst., Bologna, Ser. 4, vol. vi.*, p. 291, 1885.

Del. Zifioide Fossile (*Choneziphius planirostris*) scoperto nelle sabbie plioceniche di Fangonero presso Siena. *Atti R. Acc. Lincei, Ser. 4, vol. i.*, p. 18, 1885.

CHARLESWORTH, E.—Notice of the Teeth of *Carcharias megalodon* occurring in the Red Crag of Suffolk. *Mag. Nat. Hist., Ser. 2, vol. i.*, p. 225, 1837.

On the Occurrence of the genus *Physeter* (or Sperm Whale) in the Red Crag of Felixstow. *Proc. Geol. Soc., vol. iv.*, No. 99, p. 286, 1843, and *Quart. Journ. Geol. Soc., vol. i.*, p. 40, 1845.

DAWKINS, W. BOYD.—On a New Species of Deer from the Norwich Crag. *Quart. Journ. Geol. Soc., vol. xxiv.* p. 516, 1868.

Contributions to the History of the Deer of the European Miocene and Pliocene Strata. *Quart. Journ. Geol. Soc., vol. xxxiv.*, p. 402, 1878.

On the alleged existence of *Ovibos moschatus* in the Forest Bed, and its range in space and time. *Quart. Journ. Geol. Soc., vol. xxxix.*, p. 575, 1883.

A contribution to the History of the Pleiocene and Pleistocene Deer. Part 1, *Cervus verticornis*, *Cervus Savini*. *Proc. Roy. Soc., vol. 38*, p. 345, 1885.

On a Skull of *Ovibos moschatus* from the Sea bottom. *Quart. Journ. Geol. Soc., vol. xli.*, p. 242, 1885.

The British Pleistocene Mammalia—Cervidæ. *Palæont. Soc., vol. for 1886*, 1887.

On *Ailurus anglicus*, a new Carnivore from the Red Crag. *Quart. Journ. Geol. Soc., vol. xliv.*, p. 228, 1888.

DEPÉRET, C.—Nouvelles études sur les Ruminants pliocènes et quaternaires d'Auvergne. *Bull. Soc. Géol. France, Sér. 3, vol. xiii.*, p. 247, 1884.

Description des Vertébrés Fossiles du Terrain Pliocène du Roussillon. *Ann. Sci. Géol., vol. xvii.*, p. 137, 1885.

DU BUS, LE VICOMTE.—Sur quelques Mammifères du crag d'Anvers. *Bull. Ac. Roy. Belg., Sér. 2, vol. xxiv.*, p. 562, 1867.

Sur différents Ziphidiens nouveaux du crag d'Anvers. *Bull. Ac. Roy. Belg., Sér. 2, vol. xxv.*, p. 621, 1868.

Mammifères nouveaux du crag d'Anvers. *Bull. Ac. Roy. Belg., Sér. 2, vol. xxxiv.*, p. 491, 1872.

FABRINI, EMILIO.—*Machairodus* (*Megantereon*) del Valdarno superiore. *Boll. Com. Geol. Ital., Ser. 3, vol. 1*, p. 161, 1890.

FILHOL, H.—Étude des Mammifères Fossiles de Saint Gérand-le-Puy (Allier). Part I., *Ann. Sci. Géol., vol. x.*, Art. 3, 1879. Part II., *ibid., vol. xi.*, Art. 1, 1880.

Étude des Mammifères Fossiles de Ronzon (Haute-Loire.). *Ann. Sci. Géol., vol. xii.*, Art. 3, 1881.

FISHER, REV. O.—On the occurrence of *Elephas meridionalis* at Dewlish, Dorset. *Quart. Journ. Geol. Soc., vol. xliv.*, p. 818, 1888.

FLOWER, W. H.—Description of the Skull of a species of *Halitherium* (H. *Canhami*) from the Red Crag of Suffolk. *Quart. Journ. Geol. Soc., vol. xxx.*, p. 1, 1874.

Description of the skull of a species of *Xiphodon*, Cuvier. *Proc. Zool. Soc., p. 3*, 1876.

FLOWER, W. H.—Note on the occurrence of the remains of *Hyænarctos* in the Red Crag of Suffolk. *Quart. Journ. Geol. Soc.*, vol. xxxiii., p. 534, 1877.

Catalogue.—Osteology and Dentition of Vertebrated Animals recent and extinct, contained in the Museum of the Royal College of Surgeons of England. Part II., 1884.

GAUDRY, A.—Animaux fossiles du Léberon (Vaucluse). *Compt. Rendu.*, 15 April 1872.

GERVAIS, PAUL.—Note on *Sphaerodus cinctus* of Lawley. *Journ. Zool.*, vol. iv., p. 516, 1875.

GUNN, J.—*Elephas meridionalis* in the Red Crag. *Geol. Mag.*, vol. vi., p. 143, 1869.

Elephas meridionalis in the Norwich Crag. *Ibid.*, p. 237.

“Memorials of John Gunn.” 8vo. 1891.

HIGGINS, E. T.—On the Otolites of Fish and their value as a test in verifying recent and fossil Species. *Journ. Linn. Soc., Zool.*, vol. ix., p. 157, 1867.

HUXLEY, T. H.—On the Cetacean Fossils termed “*Ziphius*” by Cuvier, with a notice of a new species (*Belemnoziphius compressus*) from the Red Crag. *Quart. Journ. Geol. Soc.*, vol. xx., p. 388, 1864.

KOKEN, ERNST.—Ueber Fisch-Otolithen, insbesondere über diejenigen der norddeutschen Oligocän-Ablagerungen. *Zeitsch. deutsch. geol. Ges.*, 1884, p. 500, and 1888, p. 274.

Ueber die Miocänen Säugetier-Reste von Kieferstädtl in Oberschlesien und über *Hyænartos minutus*, Schlosser, MS. *Sitzbr. Ges. Nat. Freunde, Berlin*, Nr. 3, p. 47, 1888.

LANKESTER, E. RAY.—New species of Fish from the Crag. *Geologist*, vol. vi., p. 110, 1863.

On a new species of *Hyæna* from the Red Crag of Suffolk. *Ann. Mag. Nat. Hist.*, Ser. 3, vol. xiii., p. 56, 1864.

On new Mammalia from the Red Crag. *Ann. Mag. Nat. Hist.*, Ser. 3, vol. xiv., p. 353, 1864.

On the Crags of Suffolk and Antwerp. *Geol. Mag.*, vol. ii., pp. 103 and 149, 1865.

On the Sources of the Mammalian Fossils of the Red Crag, and on the Discovery of a new Mammal in that Deposit allied to the Walrus. *Quart. Journ. Geol. Soc.*, vol. xxi., p. 221, 1865, and *Geol. Mag.*, vol. ii., p. 128, 1865; also *Trans. Linn. Soc.*, Ser. 2, *Zool.*, vol. ii., part 3, p. 213, 1882.

On the structure of the Tooth of *Ziphius Sowerbiensis*, and on some Fossil Cetacean Teeth. *Trans. Micr. Soc.*, Ser. 2, vol. xv., p. 55, 1867.

The Suffolk Bone-bed and the Diestien or Black Crag in England. *Geol. Mag.*, vol. v., p. 254, 1868.

The Mammalia of the Crag. *Geol. Mag.*, vol. vi., p. 47, 1869.

Elephas meridionalis in the Norwich Crag. *Geol. Mag.*, vol. vi., p. 190, 1869.

Note on a New Trilophodont Crag Mastodon. *Geol. Mag.*, vol. vi., p. 355, 1869.

Contributions to a knowledge of the Newer Tertiaries of Suffolk and their Fauna. *Quart. Journ. Geol. Soc.*, vol. xxvi., p. 493, 1870.

A New Ziphoid Cetacean from the Suffolk Bone-bed (*Choneziphius Packardi*). *Ibid.*, p. 502, 1870.

LAWLEY, R.—Dei Resti di Pesci fossili del Pliocene Toscano. *Atti Soc. Tosc. Nat. Sci. Pisa*, vol. i., fasc. 1, p. 59, 1875.

Observation sur une Machoire fossile provenant du genre *Sphærodus*, trouvée en Toscane dans le Pliocène de Volterrano. *Journ. Zool.*, vol. iv., p. 511, and *Atti Soc. Tosc. Nat. Sci. Pisa*, vol. ii., p. 60., 1876.

Studi comparativi sui Pesci fossili coi viventi dei generi *Carcharodon*, *Oxyrhina* e *Galeocerdo*. 4to. *Pisa*, 1881.

LE HON, H.—Préliminaires d'un Mémoir sur les Poissons Tertiaires de Belgique. *Bruxelles*, 1871.

LYDEKKER, R.—Sewalik Mammalia. *Palæont. Indica*, Ser. 10., vol. ii., 1881-84.

Notes on some Fossil Carnivora and Rodentia. *Geol. Mag.*, Dec. 3, vol. i., p. 442, 1884.

Catalogues of the Fossil Mammalia in the British Museum (Natural History), 1885-87.

On a mandible of *Machaerodus* from the Forest Bed. *Quart. Journ. Geol. Soc.*, vol. xlii., p. 309, 1886.

Note on some Vertebrata from the Red Crag. *Ibid.*, p. 364, 1886.

The Cetacea of the Suffolk Crag. *Quart. Journ. Geol. Soc.*, vol. xliii., p. 7, 1887.

On a Molar of a Pliocene type of *Equus* from Nubia. *Ibid.*, p. 161, 1887.

On the Occurrence of the Striped *Hyæna* in the Tertiary of the Val d'Arno. *Quart. Journ. Geol. Soc.*, vol. xlvi., p. 62, 1890.

MACKIE, S. J.—Some Bits of Horns from Folkestone. *Geologist*, vol. iv., p. 465, 1861.

MAJOR, C. J. FORSYTH.—Considerazioni sulla Fauna Mammiferi pliocenici e post pliocenici della Toscana. *Atti Soc. Tosc. Nat.*, vol. i., fasc. 1. p. 7, 1875, fasc. 3, p. 223, 1876, vol. iii., p. 207, 1878.

Alcune Parole sulla *Sphærodus cinctus* (di Lawley) del Pliocene Volterrano. *Atti Soc. Tosc. Nat.*, vol. iv., p. 111, 1879.

On the Mammalian Fauna of the Val d'Arno. *Quart. Journ. Geol. Soc.*, vol. xli., p. 1, 1885.

NEWTON, E. T.—The Vertebrata of the Forest Bed. *Mem. Geol. Surv.*, 1882.

On the occurrence of the Cave *Hyæna* in the Forest Bed at Corton Cliff, Suffolk. *Geol. Mag.*, Dec. 2, vol. x., p. 433, 1883.

Note on some recent additions to the Vertebrate Fauna of the Norfolk "Preglacial Forest Bed." *Geol. Mag.*, Dec. 3, vol. iv., p. 145, 1887.

Some additions to the Vertebrate Fauna of the Norfolk "Preglacial Forest Bed," with description of a new species of Deer (*Cervus rectus*). *Geol. Mag.*, Dec. 3, vol. vi., p. 145, 1889.

On the occurrence of Antelope remains in the newer Pliocene Beds in Britain, with the description of a new species, *Gazella anglica*. *Quart. Journ. Geol. Soc.*, vol. xl., p. 280, 1884.

A contribution to the History of the Cetacea of the Norfolk Forest Bed. *Quart. Journ. Geol. Soc.*, vol. xlii., p. 316, 1886.

On some new Mammals from the Red and Norwich Crags. *Quart. Journ. Geol. Soc.*, vol. xlvi., p. 444, 1890.

On the occurrence of the Tunny (*Thynnus thynnus*) in the Cromer. "Forest Bed." *Geol. Mag.*, Dec. 3, vol. vii., p. 264, 1890.

NOETLING, FRITZ.—Die Fauna des samländischen Tertiärs. *Abhandl. geol. Specialkarte Preuss.*, vol. vi., Heft 3, 1885.

OWEN, R.—In C. Lyell's paper, On the discovery of Fossil Teeth of a Leopard, Bear, and other animals in a Crag Pit at Newbourn, in Suffolk. *Ann. Mag. Nat. Hist.* vol. iv., p. 186, 1840.

Report on the British Fossil Mammalia. *Brit. Assoc. Rep.* for 1842, p. 54, and for 1843, p. 208.

Appendix to Professor Henslow's Paper, consisting of a Description of the Fossil Tympanic Bones referable to four distinct species of *Balaena*. *Proc. Geol. Soc.*, vol. iv., p. 283, 1843, and *Quart. Journ. Geol. Soc.*, vol. 1, p. 37, 1845.

Description of some Mammalian Fossils from the Red Crag of Suffolk. *Quart. Journ. Geol. Soc.*, vol. xii., p. 217, 1856.

British Fossil Cetacea from the Crag. *Pal. Soc. for* 1869, 1870.

PRESTWICH, J.—On the Structure of the Crag Beds of Norfolk and Suffolk. *Quart. Journ. Geol. Soc.*, vol. xxvii., pp. 115, 325, 452, 1871.

PROBST, J.—Beiträge zur Kenntniss der fossilen Fische aus der Molasse von Baltringen. *Jahresh. Ver. Nat. Württ.*, vol. xxxv., p. 126, 1879. *Stuttgart*.

RÜTIMEYER, L.—Beiträge zu einer natürlichen Geschichte der Hirsch. *Abhandl. schweiz. pal. Ges.*, vol. viii., 1881.

RUTOT, A.—Note sur l'extension de *Lamna elegans*, Ag., à travers les terrains crétacé et tertiaire! *Ann. Soc. Géol. Belg.*, vol. ii., *Mémoires*, p. 34, 1875.

STORMS, RAYMOND.—Sur la présence du Genre *Thynnus* dans les dépôts Pliocène des Environs d'Anvers. *Bull. Soc. Belge Géol.*, vol. iii., p. 163, 1889.

TAYLOR, J. E.—On the occurrence of Elephant remains in the Basement Bed of the Red Crag. *Brit. Assoc. Rep. for* 1873, p. 91, 1874; a fuller account of this paper appeared in the "Bradford Observer," Sept. 22, 1873.

VINCENT, G.—Documents relatifs aux Sables Pliocènes à "Chrysodomus contraria" d'Anvers. *Bull. Soc. Malac. Belg.*, vol. xxiv., p. xxviii., 1889.

VIGUIER, M.—Étude sur le Pliocène de Montpellier. *Bull. Soc. Géol. France*, Sér. 3, vol. xvii., p. 379, 1889.

WEITHOFER, A.—Ueber die tertiären Landsäugethiere Italiens. *Jahrb. k.k. geol. Reichsanstalt*, vol. xxxix., p. 55, 1889.

WHITAKER, W.—The Geology of the Country around Ipswich, &c. *Mem. Geol. Surv. England and Wales*, 1885.

WOODWARD, A. SMITH.—On the Palæontology of the Selachian genus *Notidanus*, Cuvier. *Geol. Mag.*, Dec. 3, vol. iii., p. 205, 1886.

Catalogue of the Fossil Fishes in the British Museum (Natural History), Part I., *Elasmobranchii*, 1889.

Evidence of a Fossil Tunny from the Coralline Crag. *Ann. Mag. Nat. Hist.*, ser. 6, vol. v., p. 294, 1890.

WOODWARD, A. SMITH, and C. DAVIES SHERBORN.—A catalogue of British Fossil Vertebrata, 1890.

WOODWARD, H. B.—The Geology of the Country around Norwich. *Mem. Geol. Surv. England and Wales*, 1881.

Memorials of John Gunn. 8vo. Norwich, 1891.

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PLATE I.

*All figures natural size except 15c., and all from the Red Crag Nodule-bed,
except figures 2, 5, 8, 13, 14, 16.*

1, a, b. **FELIS PARDOIDES**, *Owen*. Lower first molar; *a*, outer, and *b*, inner side. Type specimen. Newbourn. Ipswich Mus.

2, a, b. **MACHÆRODUS?** Carnassial tooth, inner and outer sides. Norwich Crag. Thorpe. Fitch Coll.

3, a, b. **CANIS LUPUS**, *Linnæus*. Left upper canine; *a*, outer, and *b*, inner side. Boyton. Reed Coll., York Mus.

4, a, b. **CANIS LUPUS**, *Linnæus*. Left upper carnassial (pm. 4); *a*, outer, *b*, inner side. Loc. ? Reed Coll., York Mus.

5. **CANIS VULPES**, *Linnæus*. Right half of upper jaw from Red Crag above Nodule bed, Boyton. Brit. Mus.

6. **CANIS?** **PRIMIGENIUS**, *Lankester*. Type. Woodbridge. Reed Coll., York Mus.

7, a, b. **PTERODON?** After Owen. Two views of Red Crag type. Woodbridge.

8, a, b. **HYÆNA CROCUTA**, *Erxleben*. Right upper carnassial (pm. 4); *a*, outer, *b*, inner side. Forest-bed, Corton Cliff. Colman Coll.

9, a, b. **HYÆNA STRIATA**, *Zimmerman*. Right upper carnassial (pm. 4). Trimley St. Mary, nr. Felixstow. Ipswich Mus.

10, a, b. **HYÆNA STRIATA**, *Zimmerman*. Right lower pm. 4; *a*, outer, *b*, inner side. Woodbridge. Reed Coll., York Mus.

11. **HYÆNARCTOS?** Small canine tooth. Woodbridge. Reed Coll., York Mus.

12, a, b. **URSUS ARVERNENSIS?** Left lower, second molar; *a*, from above, *b*, inner side. Woodbridge. Reed Coll., York Mus.

13, a, b, c. **LUTRA REEVEI**, *Newton*. Probably a right, lower carnassial tooth; *a*, upper surface, *b*, hinder end, *c*, outer side. Norwich Crag, Bramerton. Reeve Coll., Norwich.

14. **CARNIVORE** tooth. Grinding surface. Crag [?] Kessingland. Wisbeach Mus.

15, a, b, c. **LUTRA DUBIA**, *Blainville*. Right ramus of lower jaw; *a*, outer surface, *b*, from above, *c*, carnassial tooth enlarged. Foxhall, 4½ m. S.W. of Woodbridge. Moor Coll., Great Bealings.

16, a, b. **LUTRA VULGARIS**, *Erxleben*. Left ramus of lower jaw; *a*, outer surface, *b*, from above. Forest-bed, Mundesley. Savin Coll., Cromer.

17, a, b. **AILURUS ANGLICUS**, *Dawkins*. Right ramus of lower jaw; *a*, outer surface, *b*, seen from above. Felixstow. Reed Coll., York Mus.

18, a, b. **AILURUS ANGLICUS**, *Dawkins*. Left upper first molar; *a*, grinding surface, *b*, outer side. Butley. Presented by Mr. P. H. Browne to M. P. G.*

19, a, b. Corresponding tooth of recent *Ailurus fulgens* for comparison with figure 18.

20, a, b. **HYÆNARCTOS**. Left upper first molar; *a*, grinding surface, *b*, end view. Felixstow. Reed Coll., York Mus.

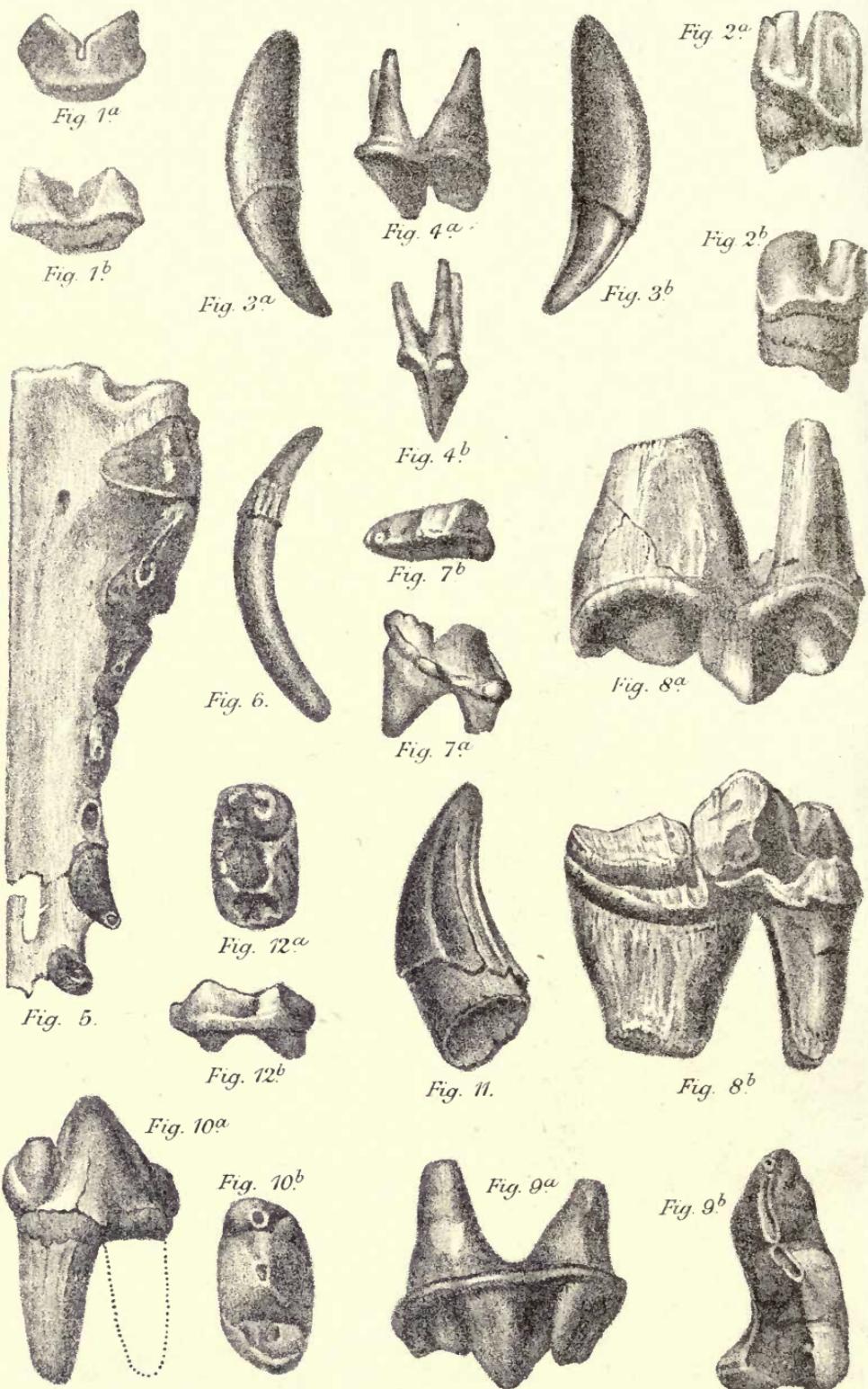
21. **HYÆNARCTOS**. Right lower second molar, grinding surface. Felixstow. Reed Coll., York Mus.

22. **HYÆNARCTOS**. Right lower canine, inner side. Felixstow. Reed Coll., York Mus.

* M. P. G. = Museum of Practical Geology.



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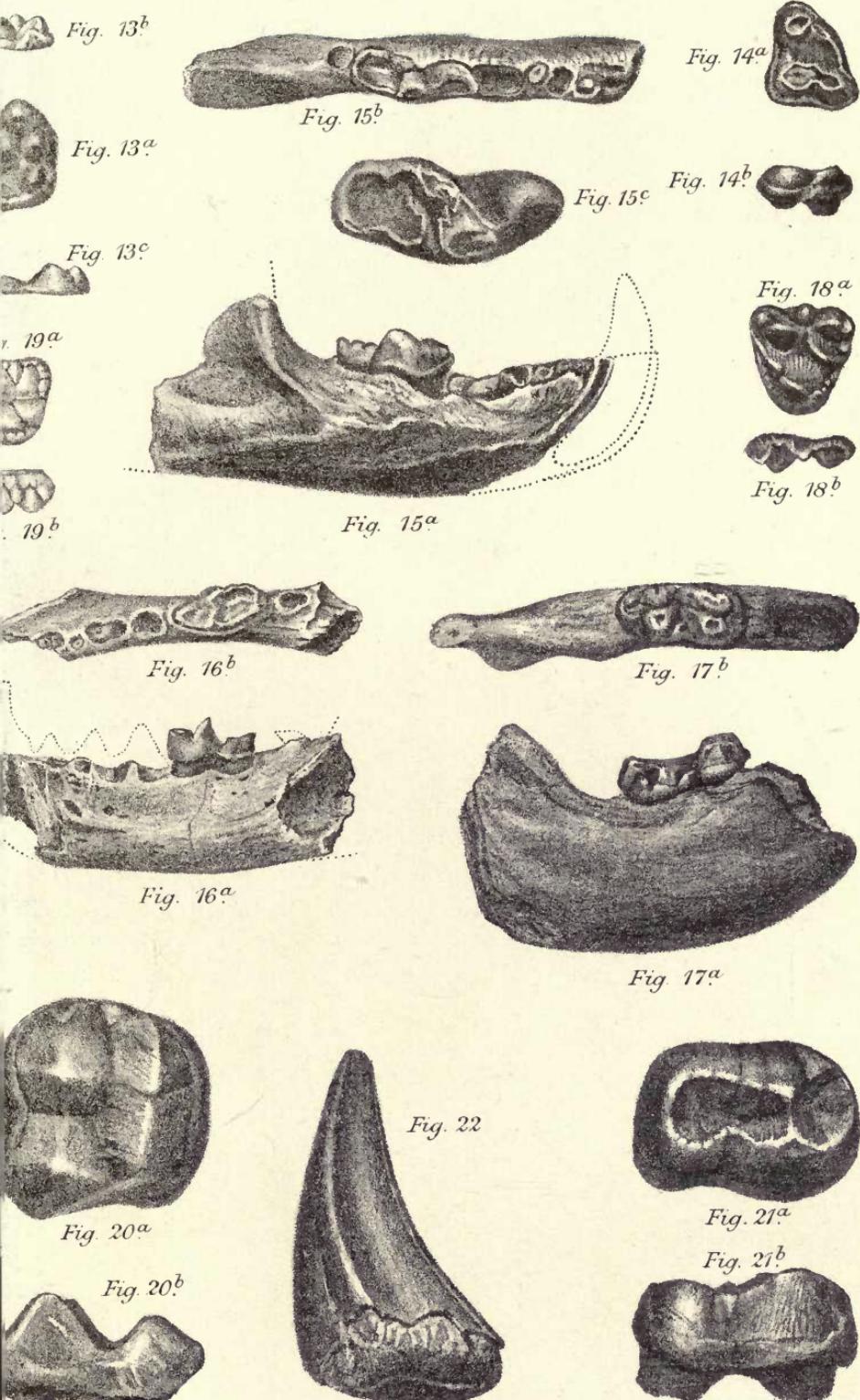




PLATE II.

1, a. *PHOCA* sp. Right humerus, $\frac{2}{3}$ natural size, outer side. Norwich Crag, Bramerton. Crowfoot and Dowson Coll., Norwich Mus.

1, b. Same specimen, front view.

2, a. *PHOCA MOORI*, *Newton*. Left humerus, natural size, inner side. Red Crag Nodule-bed. Foxhall, $4\frac{1}{2}$ m. S.W. of Woodbridge. Moor Coll., Great Bealings.

2, b. Same specimen, front view.

3. *TRICHECHUS HUXLEYI?* *Lankester*. Portion of right femur, $\frac{2}{3}$ natural size. Chillesford Beds, Crag Pit, Aldeby. Crowfoot and Dowson Coll., Norwich Mus.

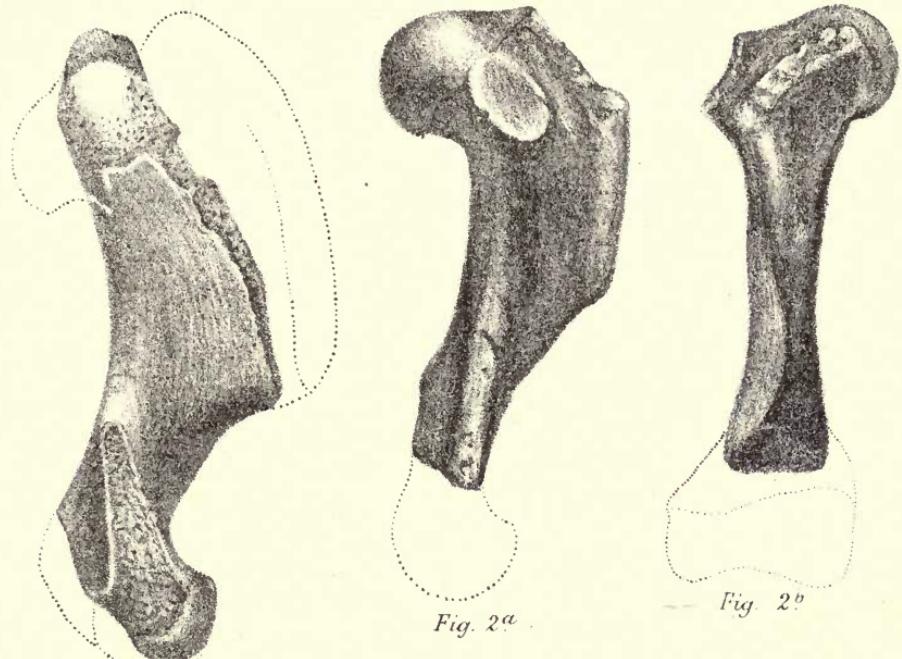


Fig. 1^a x 2₃

Fig. 2^a

Fig. 2^b

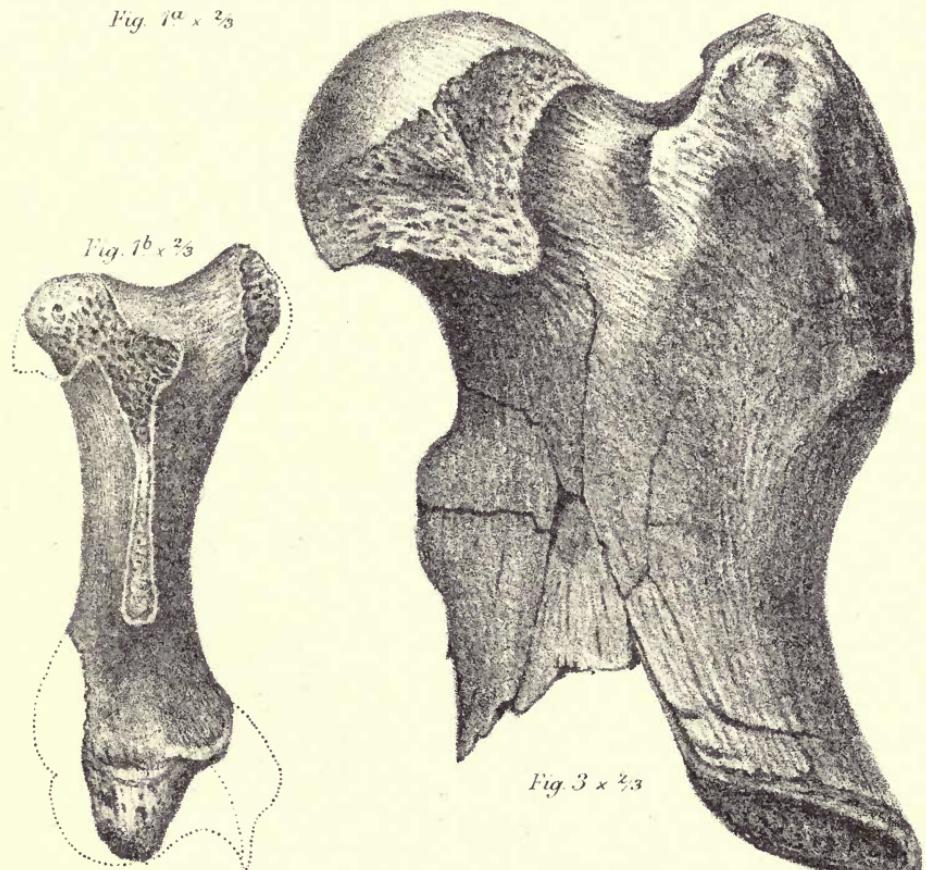


Fig. 1^b x 2₃

Fig. 3 x 2₃



III. ВТАЧ

PLATE III.

All figures natural size. All from Red Crag Nodule-bed, except figures 6, 7, 10.

1. BOVINE lower molar, outer side. Boyton. M. P. G.
- 2, a, b, c. ANTILOPE? Upper molar; a, inner side, b, grinding surface, c, end view. Woodbridge. M. P. G.
- 3, a, b, c. ANTILOPE? Lower molar; a, outer side, b, grinding surface, c, end view. Woodbridge. M. P. G.
- 4, a, b. ANTILOPE? Lower last molar; a, outer side, b, grinding surface. Sutton. M. P. G.
- 5, a, b, c. ANTILOPE? Small lower grinder; a, outer side, b, grinding surface, c, end view. Boyton. M. P. G.
- 6, a, b, c. GAZELLA ANGLICA, Newton. Right frontal with horncore; a, outer side, b, front view, c, section of horncore. Norwich Crag, Thorpe. M. P. G.
7. Small ruminant, genus? Metatarsal. Coralline Crag, Gedgrave. Presented by Col. Alexander to M. P. G.
- 7, a, b. Two views of a first phalanx obtained with the metatarsal, figure 7.
- 8, a, b. CERVUS. Left lower last molar; a, outer side, b, grinding surface. Woodbridge. M. P. G.
- 9, a, b. CERVUS. Upper molar; a, inner side, b, grinding surface. Boyton. M. P. G.
10. Outer incisor of small ruminant. Norwich Crag, Thorpe. Fitch Coll., Norwich.
- 11, a, b. SUS ANTIQUUS, Kaup. Last upper molar; a, grinding surface, b, side view. Suffolk Crag. Ipswich Mus.
- 12, a, b. SUS ANTIQUUS, Kaup. Last lower molar; a, grinding surface, b, side view. Suffolk Crag. Ipswich Mus.
13. SUS PALÆOCHÆRUS, Kaup. Last upper molar. Boyton. M. P. G.
14. SUS PALÆOCHÆRUS. Last lower molar. Woodbridge. M. P. G.
- 15, a, b. SUS PALÆOCHÆRUS? Kaup. Cheek tooth probably referable to this species; but is said to be the tooth alluded to by Sir R. Owen as *Ursus* (Q. J. G. S. Vol. xii., p. 227.) Newbourn, Moor Coll., Great Bealings.
16. Metacarpal (?) of Artiodactyle, undetermined. Falkenham, near Felixstow. Moor Coll., Great Bealings.



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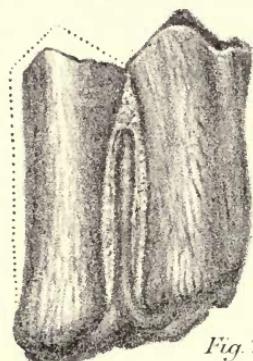


Fig. 1.

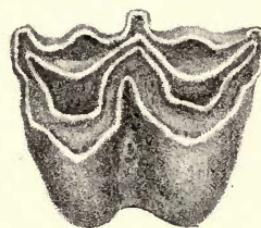


Fig. 2^b.

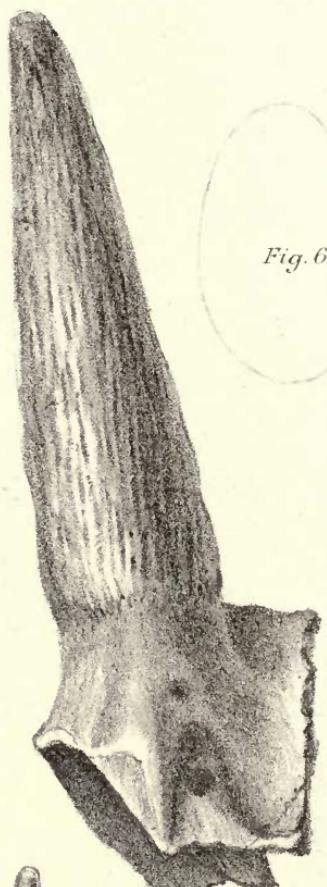


Fig. 6.

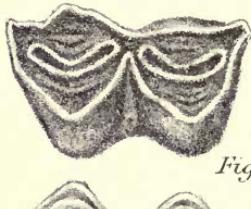


Fig. 3^b.

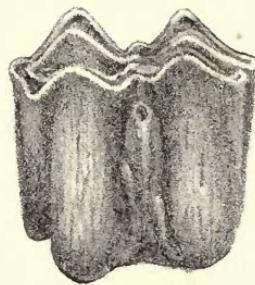


Fig. 2^a.



Fig. 3^a.

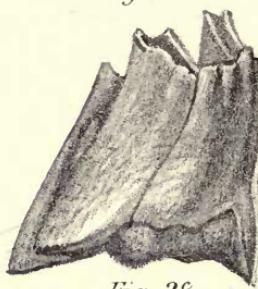


Fig. 2^c.



Fig. 3^c.

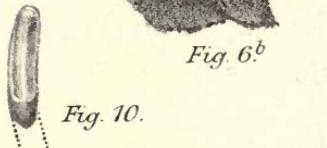


Fig. 6^b.



Fig. 5^b.

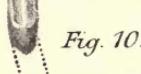


Fig. 10.



Fig. 4^b.



Fig. 5^a.



Fig. 8^b.

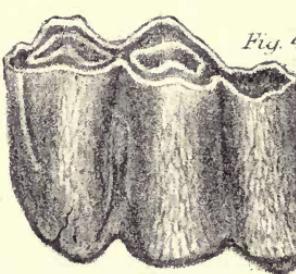


Fig. 4^a.

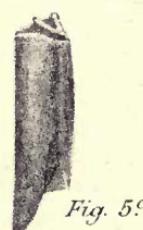


Fig. 5^c.

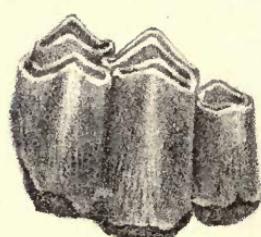


Fig. 8^a.

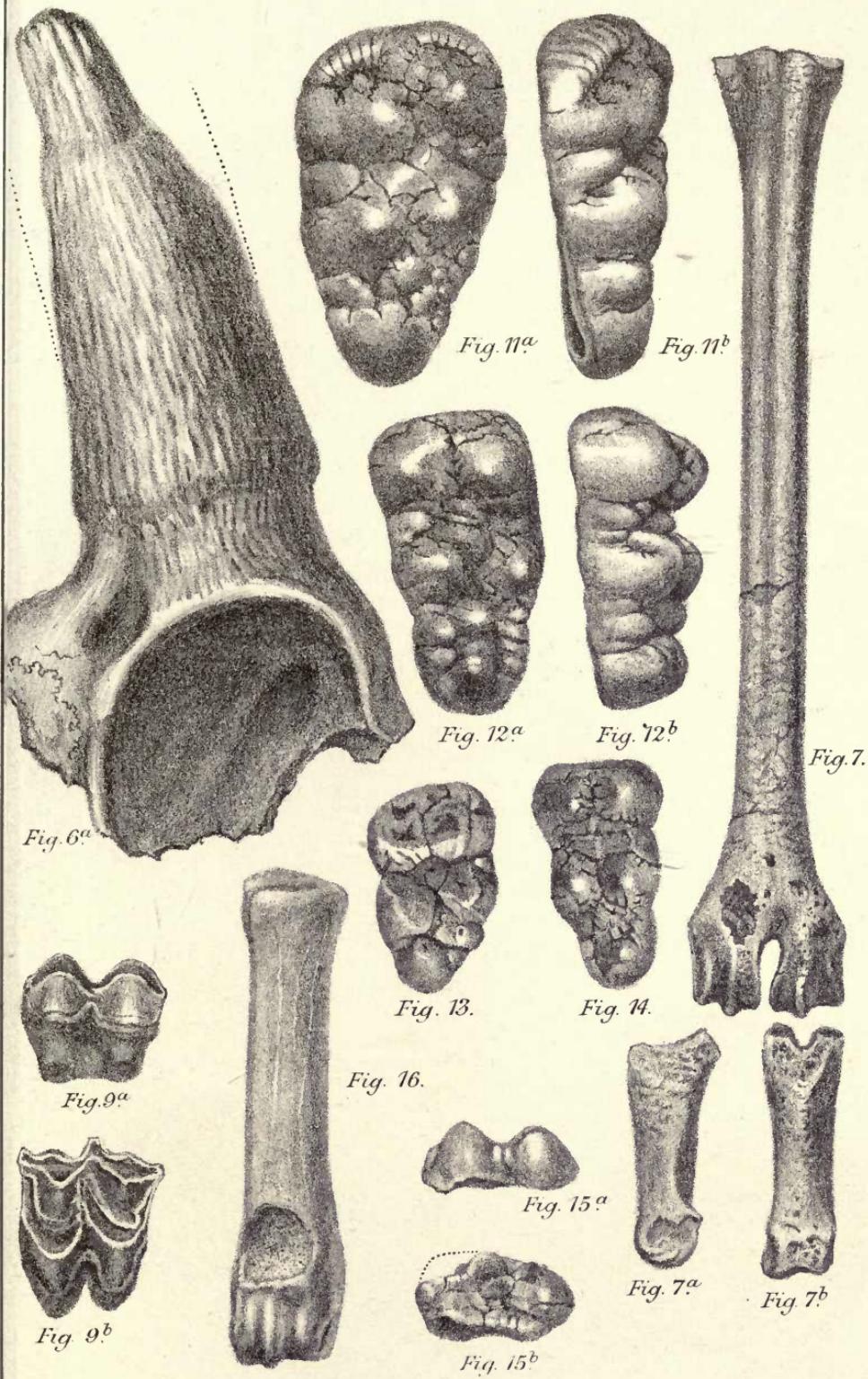




PLATE IV.

All the figures one fourth natural size.

1. **CERVUS RECTUS**, *Newton*. Right frontal, with pedicle and part of antler. Forest-bed, Sidestrand. Savin Coll.
2. **CERVUS TETRACEROS**, *Mackie*. Portion of antler. Forest-bed, East Runton. M. P. G.
3. **CERVUS CARNUTORUM**, *Laugel*. Basal portion of antler and frontal. Norwich Crag, Covehithe, Suffolk. M. P. G.
4. **CERVUS ETUERIARUM**, *Croizet* and *Jobert*. Right antler. Forest-bed, East Runton. Savin Coll.
5. **CERVUS ETUERIARUM**, *C.* and *J.* Portion of antler and frontal. Forest-bed, Cromer. King Coll., M. P. G.
6. **CERVUS ARDEUS**, *C.* and *J.* Portion of antler and frontal. Norwich Crag, Thorpe. Presented by Dr. A. King to M. P. G.
7. **CERVUS FALCONERI**, *Dawkins*. Two views of left shed antler (after Dawkins). Norwich Crag. Brit. Mus.
8. **CERVULUS DICRANOCEROS**, *Kaup*. Base of antler (after Owen). Red Crag near Sutton.
9. **CERVULUS DICRANOCEROS**, *Kaup*. Portion of antler. Red Crag (Nodule-bed). Ipswich Mus.
10. **CAPREOLUS CAPREA**, *Gray*. Antler. Forest-bed. King Coll., M. P. G.
11. **CERVUS GIGANTEUS?** *Blumenbach*. Portion of antler. Red Crag, Suffolk. (After Owen.)
12. **CERVUS POLIGNACUS**, *Robert*. Portion of antler with brow tyne (after Gunn). Forest-bed, Mundesley. Norwich Mus.
13. **CERVUS SUTTONENSIS**, *Dawkins*. Portion of shed antler. Red Crag Nodule-bed. Reed Coll., York Mus.
14. **CERVUS ELAPHUS**, *Linnæus*. Portion of antler with three tynes. Forest-bed, Kessingland. Crowfoot Coll., Beccles.



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Fig. 1.



Fig. 2.

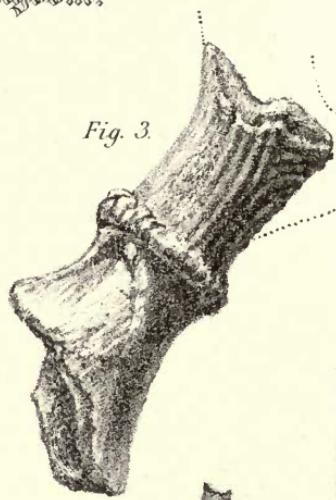


Fig. 3.

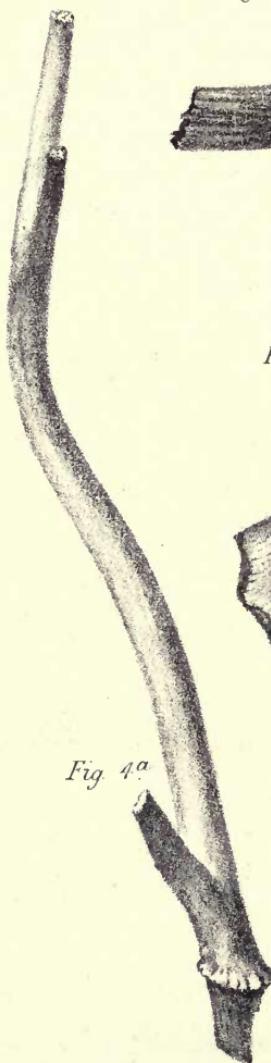


Fig. 4a.

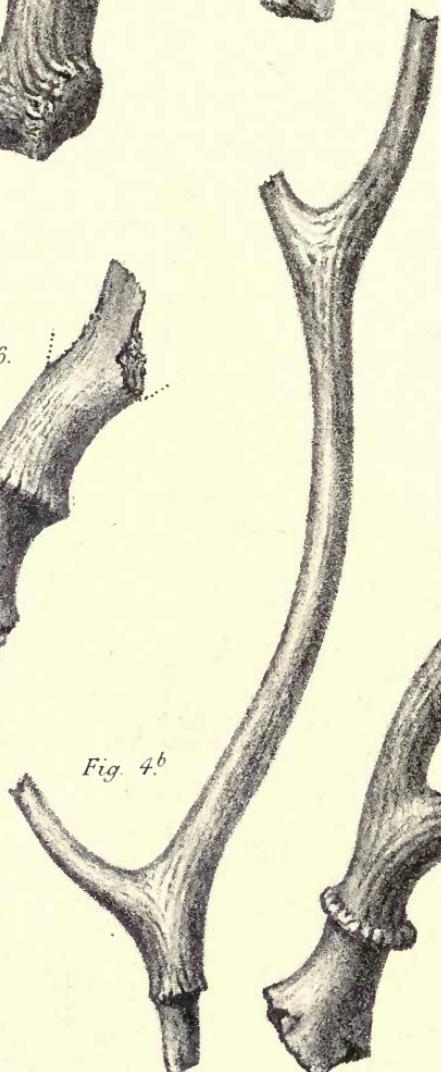


Fig. 4b.



Fig. 5.



Fig.

Fig. 6.

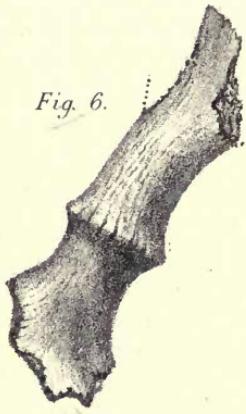




Fig. 8.

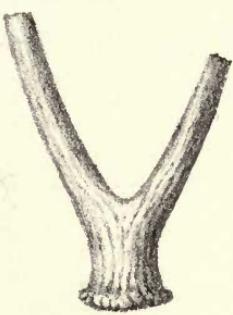


Fig. 9.

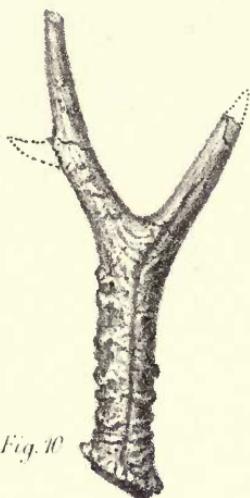


Fig. 10.



Fig. 11.

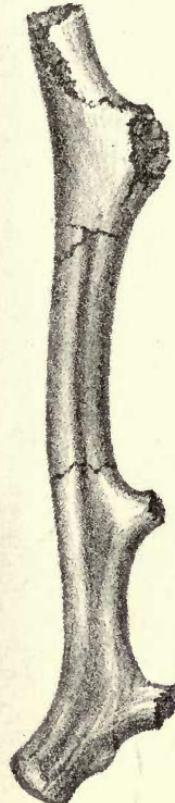


Fig. 7^b

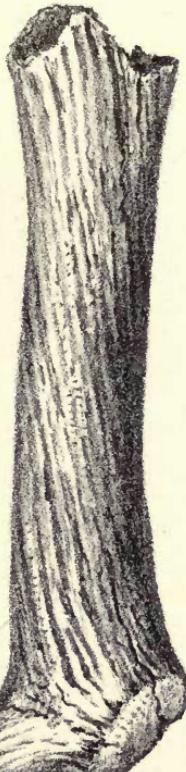


Fig. 12.

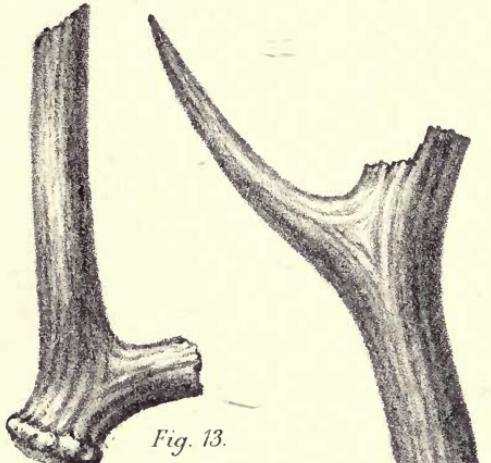


Fig. 13.

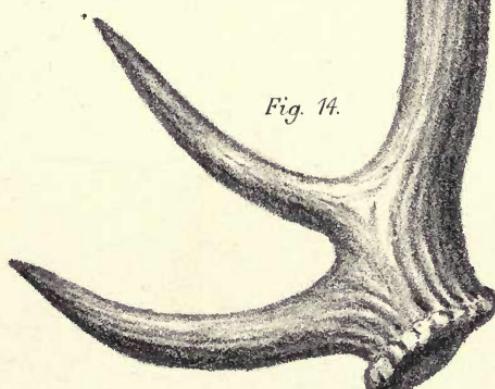


Fig. 14.



PLATE V.

All figures natural size, except 19 b., and all from the Red Crag Nodule-bed, except 7, 18, 19, which are Norwich Crag.

- 1, a, b. **RHINOCEROS INCISIVUS**, *Kaup*. Upper premolar; *a*, grinding surface, *b*, inner side. Woodbridge. M. P. G.
2. **RHINOCEROS INCISIVUS**, *Kaup*. Upper premolar, inner surface. Suffolk. Ipswich Mus.
3. **RHINOCEROS INCISIVUS**, *Kaup*. Upper premolar, grinding surface, figured by Sir R. Owen as *R. Schleiermacheri*. Wolverton, Suffolk. (After Owen.)
- 4, a, b. **RHINOCEROS SCHLEIERMACHERI**, *Kaup*. Upper premolar; *a*, grinding surface, *b*, inner side. Suffolk, Ipswich Mus.
5. **HALITHERIUM CANHAMI**, *Flower*. Cheek tooth, grinding surface. Suffolk. Reed Coll., York Mus.
6. **HYRACOTHERIUM LEPORINUM**, *Owen*. Right upper molars, grinding surface. Boyton. M. P. G.
- 7, a, b. **EQUUS STENONIS**, *Cochi*. Upper cheek tooth; *a*, grinding surface, *b*, inner side. The two corners marked by white lines have been restored. Norwich Crag, Thorpe. M. P. G.
- 8, a, b. **HIPPARION GRACILE**, *Kaup*. Lower cheek tooth; *a*, outer side, *b*, grinding surface. Woodbridge. M. P. G.
- 9, a, b. **HIPPARION GRACILE**, *Kaup*. Upper cheek tooth, unworn, *a*, inner side, *b*, transverse section. Woodbridge. M. P. G.
- 10, a, b. **TAPIRUS ARVERNENSIS**? *Dev.* and *Bou.* Lower cheek tooth; *a*, grinding surface, *b*, side view. Woodbridge. M. P. G.
- 11, a, b. **TAPIRUS ARVERNENSIS**? *D.* and *B.* Upper cheek tooth; *a*, grinding surface, *b*, end view. Boyton. M. P. G.
- 12, a, b. **CORYPHODON**. Upper cheek tooth; *a*, grinding surface, *b*, side view. Woodbridge. M. P. G.
- 13, a, b, c. **CASTOR VETERIOR**, *Lankester*. Left upper fourth premolar; *a*, inner side, *b*, outer side, *c*, grinding surface. Newbourn. Moor Coll., Great Bealings.
- 14, a, b, c. **CASTOR VETERIOR**, *L.* Left upper fourth premolar, type specimen; *a*, inner side, *b*, outer side, *c*, grinding surface. Near Sutton. Reed Coll., York Mus.
- 15, a, b. **CASTOR VETERIOR**, *Lankester*. Incisor provisionally referred to this species; *a*, outline, *b*, transverse section. Sutton. Ipswich Mus.
- 16, a, b. **CASTOR FIBER**, *Linnaeus*. Left lower fourth premolar; *a*, inner side, *b*, grinding surface. Boyton. M. P. G.
- 17, a, b. **TROGONTHERIUM MINUS**, *Newton*. Right maxilla with premolar 4 and molars 1 and 2 in place; *a*, outer side, *b*, grinding surfaces of teeth. Felixstow. Moor Coll., Great Bealings.
- 18, a, b. **TROGONTHERIUM MINUS**? Incisor tooth provisionally referred to this species; *a*, side view, *b*, transverse section. Norwich Crag, Sizewell Gap. Geol. Soc. Mus.
- 19, a, b. **RODENT**, genus? Cheek tooth; *a*, side view, *b*, transverse section, enlarged. Norwich Crag, Bramerton. Reeve Coll., Norwich.



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Fig. 1^a

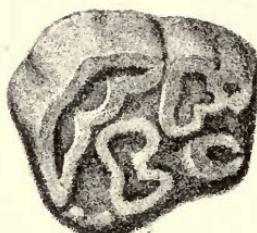


Fig. 5.

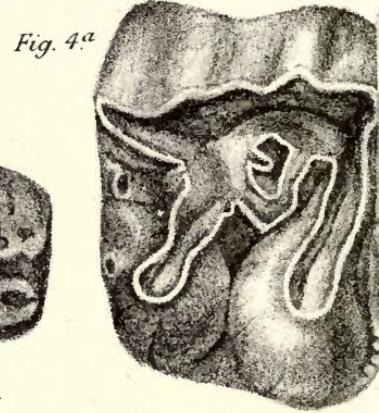


Fig. 4^a

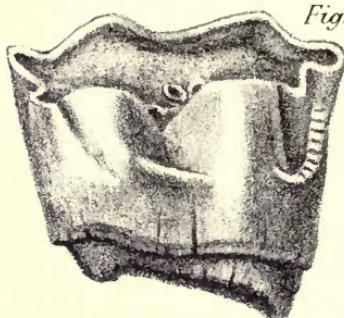


Fig. 1^b



Fig. 6.

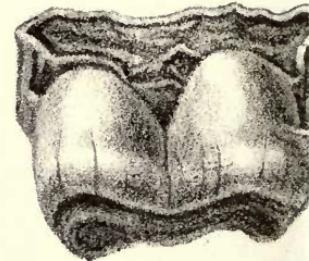


Fig. 4^b



Fig. 7^b

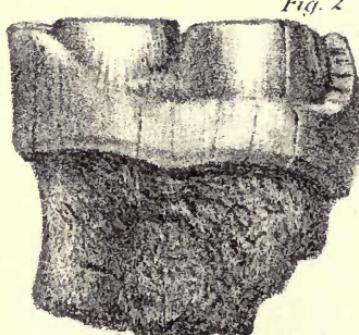


Fig. 2

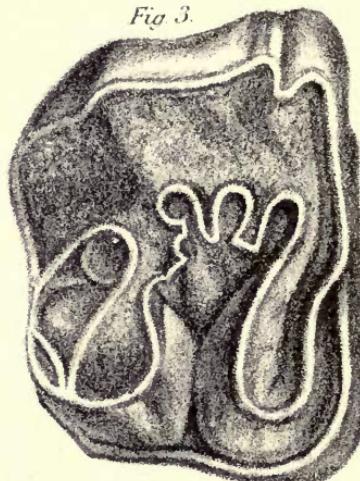


Fig. 3.



Fig. 8^b



Fig. 8^a

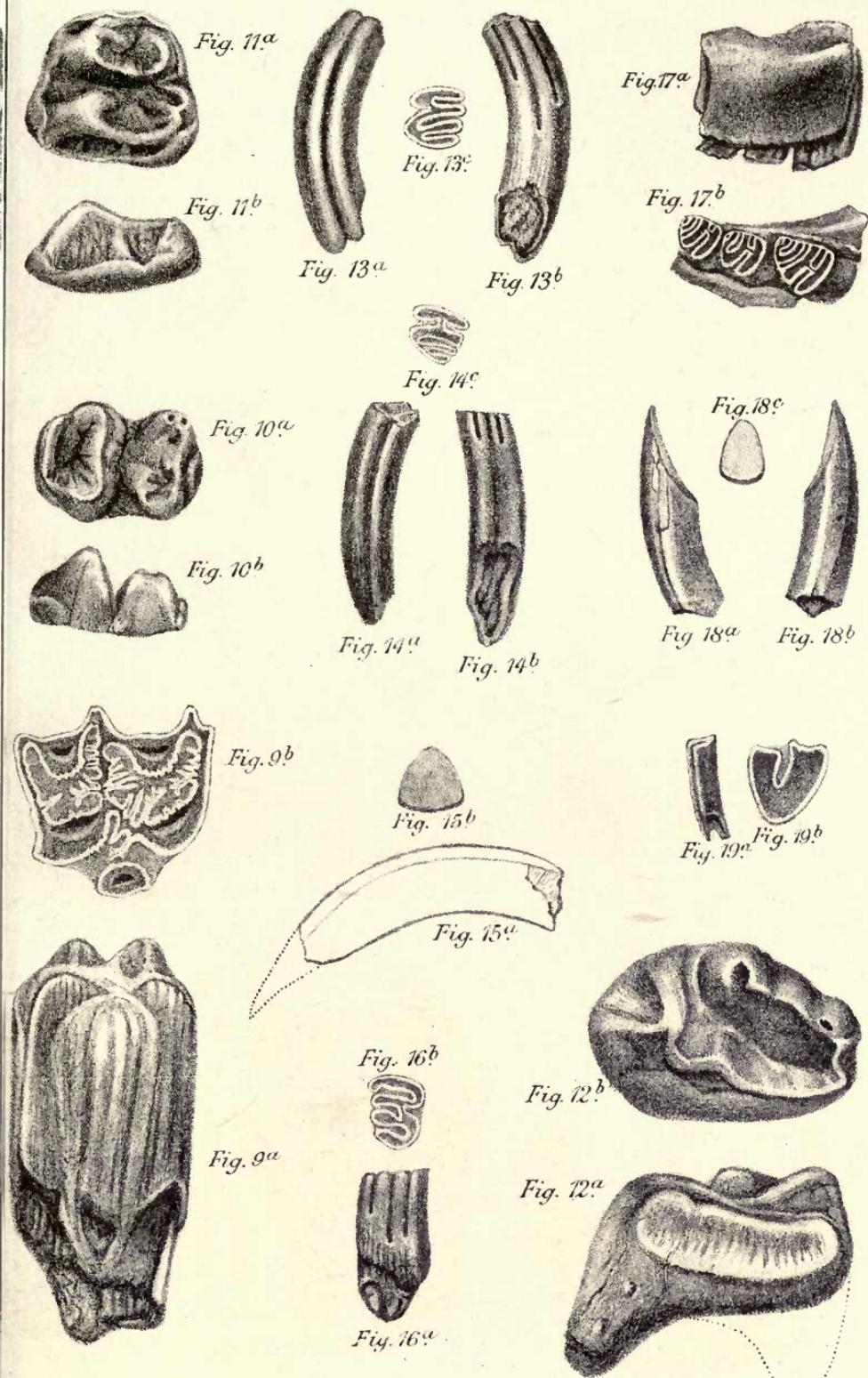


PLATE VI.

CETACEAN TYMPANIC BONES.

1, 2, 3, 6, 8, 10, 11, *right side*; 4, 5, 7, 9, *left side*; a, *inner aspect*, b, *seen from below*.

All figures half natural size, and all from Red Crag Nodule-bed, except 1, 6, and 7.

1. BALÆNA BISCAYENSIS, *Gray*. Forest-bed, East Runton. Savin Coll., Cromer.
- 2, a, b. BALÆNA PRIMIGENIA, *V. Beneden*. Woodbridge, M. P. G.
3. BALÆNA AFFINIS, *V. Beneden*. Woodbridge. M. P. G.
- 4, a, b. BALÆNA INSIGNIS, *V. Beneden*. Woodbridge. M. P. G.
- 5, a, b. BALÆNA BALÆNOPSIS, *V. Beneden*. Felixstow. M. P. G.
- 6, a, b. MEGAPTERA AFFINIS, *V. Beneden*. Coralline Crag, Sudbourn. M. P. G.
- 7, a, b. MEGAPTERA MINUTA, *V. Beneden*. (After Lydekker). Coralline Crag, Suffolk. Ipswich Mus.
- 8, a, b. BALÆNOPTERA DEFINITA, *Owen*. Felixstow. Rickman Coll., M. P. G. This figure has been accidentally reversed.
9. BALÆNOPTERA EMARGINATA, *Owen*. Felixstow. Presented by Mr. H. B. Woodward to M. P. G.
- 10, a, b. CETOTHERIUM DUBIUM, *V. Beneden*. Felixstow. M. P. G.
- 11, a, b. HERPETOCETUS SCALDIENSIS, *V. Beneden*. Felixstow. M. P. G.



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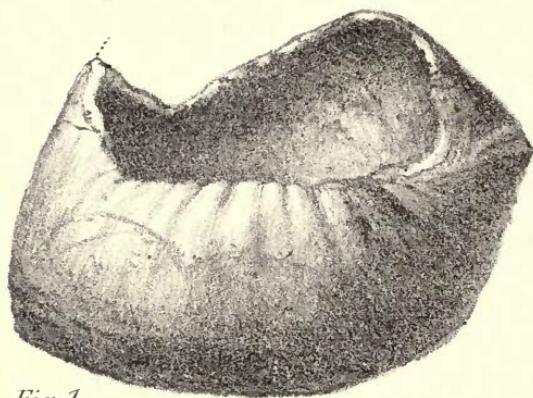


Fig. 1.



Fig. 6^a

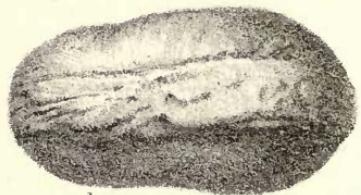


Fig. 6^b

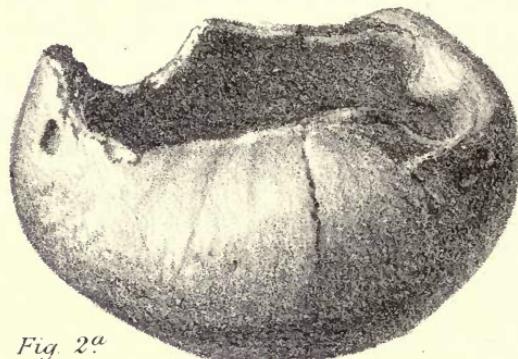


Fig. 2^a



Fig. 10^a



Fig. 2^b

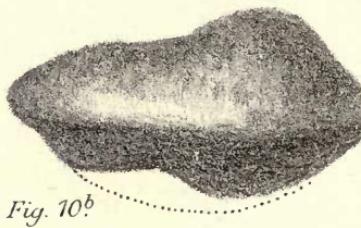


Fig. 10^b

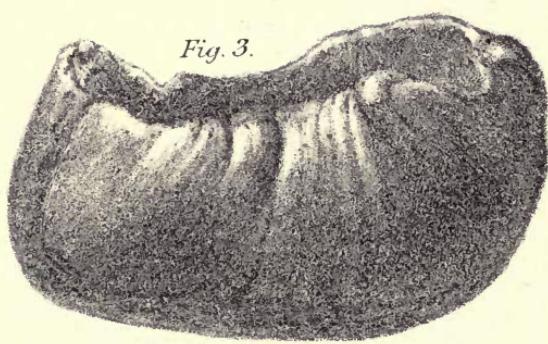


Fig. 3.

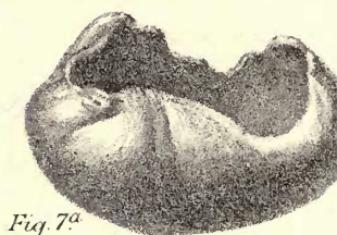


Fig. 7^a

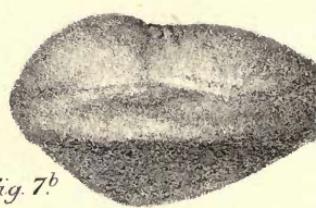


Fig. 7^b

W. M. Redaway, del. et lith.

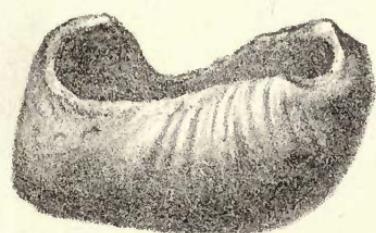


Fig. 5^a

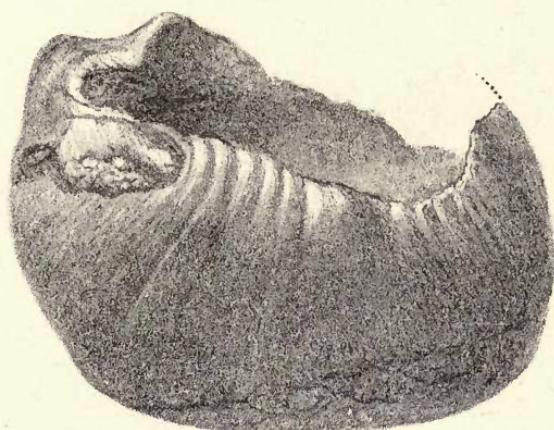


Fig. 4^a

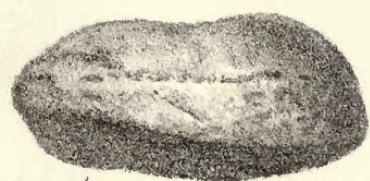


Fig. 5^b

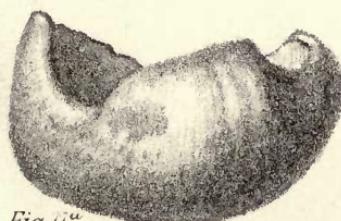


Fig. 6^a

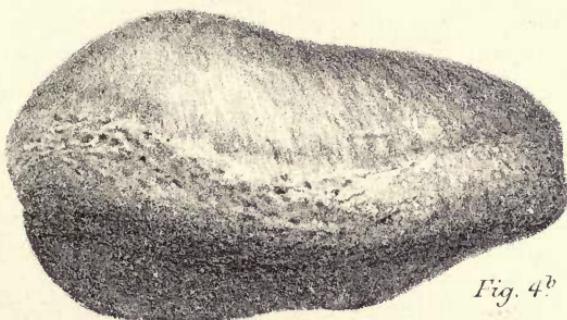


Fig. 4^b

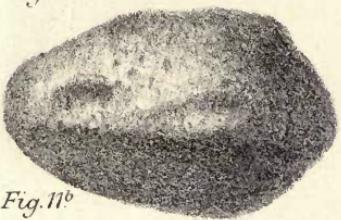


Fig. 11^b



Fig. 8^a



Fig. 9^a

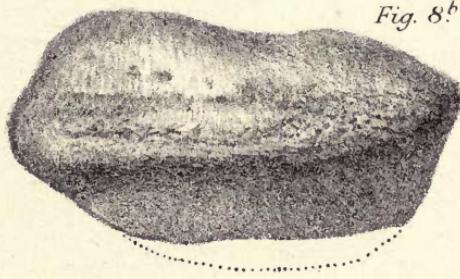


Fig. 8^b

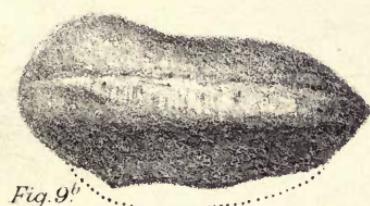


Fig. 9^b



PLATE VII.

1 *four-fifths natural size* ; 2-5 *natural size*.

1. **PHYSETER MACROCEPHALUS**, *Linnæus*. Longitudinal section of tooth. Forest-bed, Sidestrand. M. P. G.
- 2, *a*, *b*. **BALÆNODON PHYSALOIDES**, *Owen*. Half a tooth; *a*, longitudinal section showing slender core of dentine, *b*, transverse section. Red Crag Nodule-bed, Suffolk. Harford Coll., M. P. G.
- 3, *a*, *b*. **BALÆNODON PHYSALOIDES**, *Owen*. Slender tooth; *a*, exterior, *b*, longitudinal section. Red Crag Nodule-bed. Woodbridge. M. P. G.
4. **ORCA CITOINIENSIS**, *Capellini*. Tooth (after Lydekker). Red Crag Nodule-bed, Suffolk. Ipswich Mus.
5. **GLOBICEPHALUS UNCIDENS**, *Lankester*. Tooth (after Lankester). Red Crag Nodule-bed, Felixstow.
6. **GLOBICEPHALUS UNCIDENS**, *Lankester*. Tooth (after Lankester). Red Crag Nodule-bed, near Sutton, Suffolk.

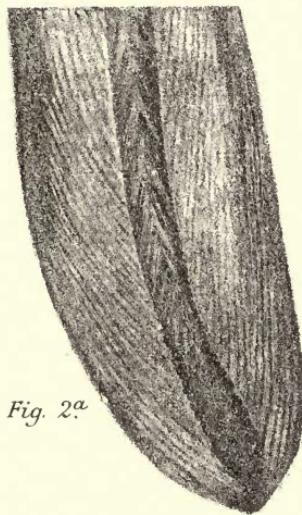


Fig. 2^a

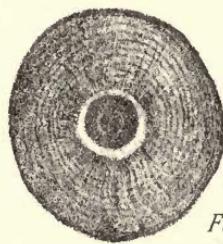


Fig. 2^b

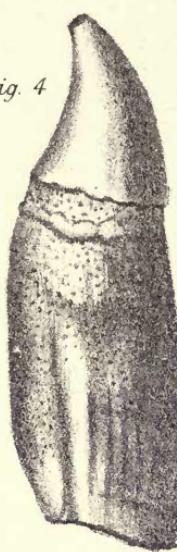


Fig. 4

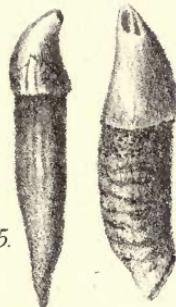


Fig. 5.

Fig. 6.

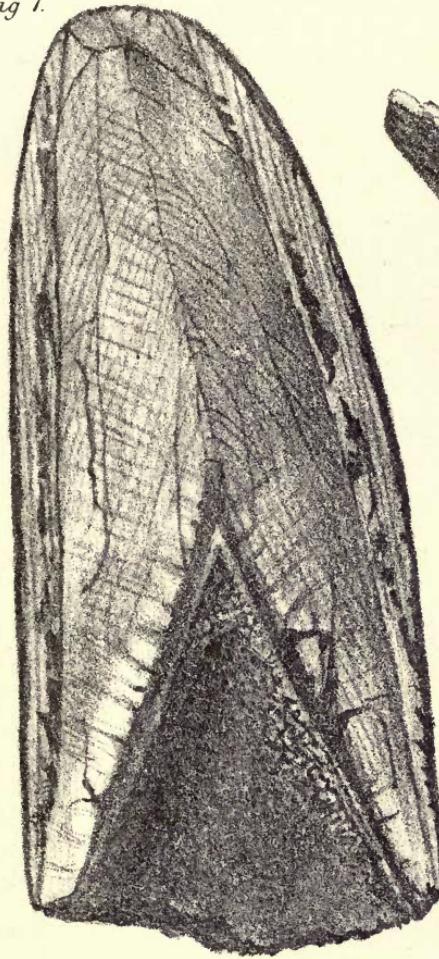


Fig. 1.



Fig. 3^a

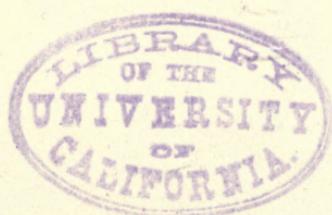
Fig. 3^b



PLATE VIII.

All figures natural size, and from the Red Crag Nodule-bed, except 14, a, b, which are half natural size, and from the Coralline Crag.

1. EU CETUS AMBLYODON, *Du Bus.* Tooth, longitudinal section showing outer layer of cementum and thick core of dentine, with globular dentine in the middle. Woodbridge. M. P. G.
2. EU CETUS AMBLYODON, *Du Bus.* Transverse section of a tooth with very thick cementum. Woodbridge. M. P. G.
3. EU CETUS AMBLYODON, *Du Bus.* Left periotic, tympanic aspect, after Lydekker. Felixstow. No. 27,854, Brit. Mus.
4. HYPEROODON. Right periotic, tympanic aspect. After Lydekker. Ipswich Mus.
5. ORCA CITONIENSIS, *Capellini.* Right periotic, tympanic aspect. Woodbridge. M. P. G.
6. CHONEZIPIHIUS PLANIROSTRIS, *Cuvier.* Left periotic, tympanic aspect. Woodbridge. M. P. G.
7. MESOPLODON LONGIROSTRIS ? *Cuvier.* Left periotic, tympanic aspect. Woodbridge. M. P. G.
8. GLOBICEPHALUS UNCIDENS, *Lankester.* Left periotic, tympanic aspect. Woodbridge. M. P. G.
9. GENUS ? Right periotic, tympanic aspect. Woodbridge. M. P. G.
- 10, a, b. } Delphinoid periotics not generically determined; a, inner face, b, tympanic aspect. } Left. Felixstow. M. P. G.
11, a, b. } Left. Woodbridge. M. P. G.
12, a, b. } Left. Boyton. M. P. G.
13. Delphinoid right tympanic. Boyton. M. P. G.
- 14, a, b. TURSIOPS TURSIO ? *Bonnaterre.* Middle caudal vertebra; a, end view, b, side view. Coralline Crag, Broom Pit, Gedgrave. Presented by Mr. Clement Reid to M. P. G.
15. SQUALODON ANTWERPIENSIS, *V. Beneden.* Side tooth. Suffolk. Reed Coll., York Mus.
16. SQUALODON ANTWERPIENSIS ? *V. Beneden.* Anterior tooth, two views. Reed Coll., York Mus.



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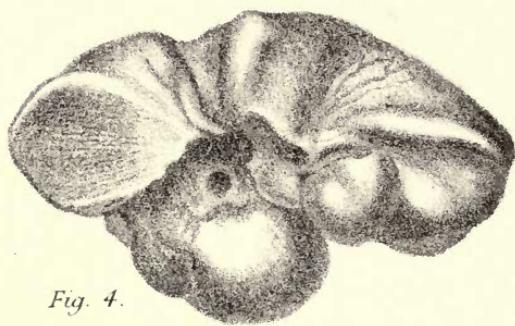


Fig. 4.

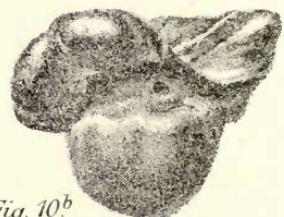


Fig. 10^b



Fig. 3.

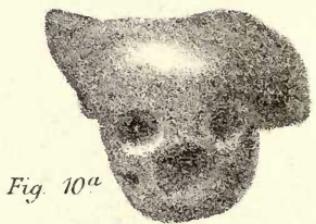


Fig. 10^a

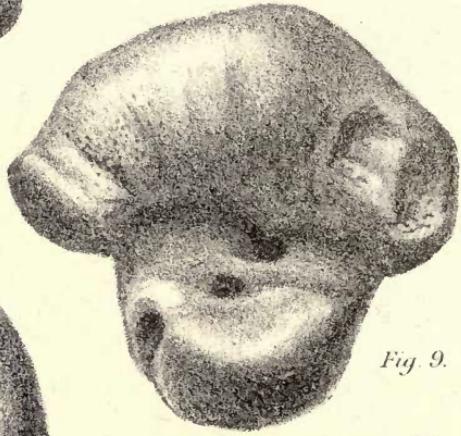


Fig. 9.

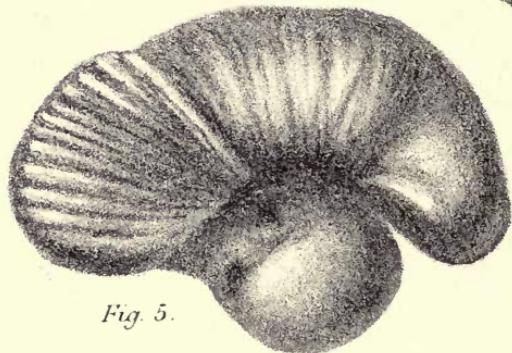


Fig. 5.



Fig. 8.

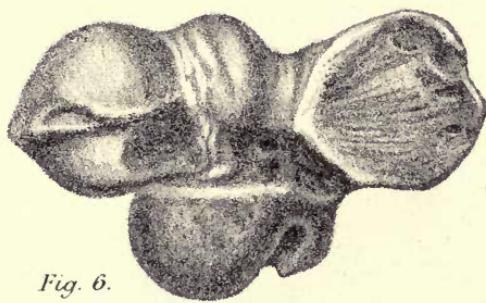


Fig. 6.

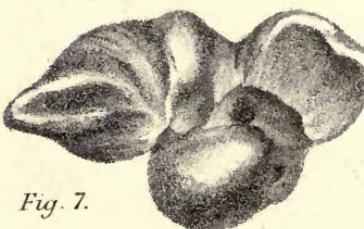


Fig. 7.

Fig. 2.

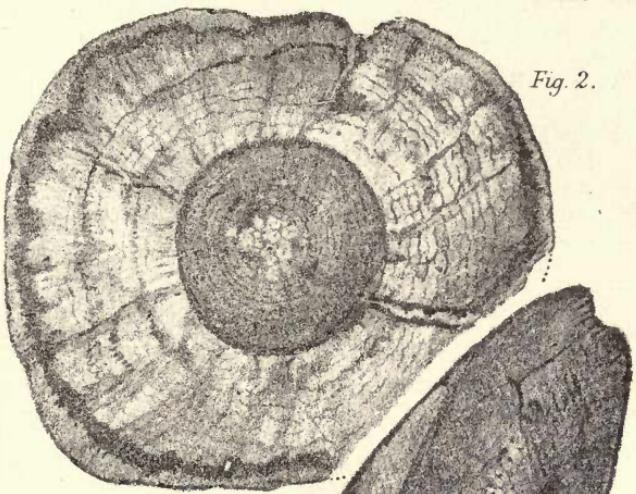


Fig. 12^b

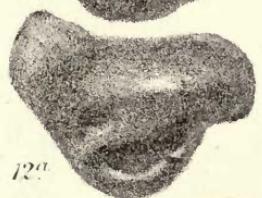


Fig. 12^a

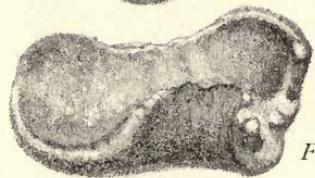


Fig. 13.

Fig. 15.

Fig. 11^b



Fig. 11^a

Fig. 14^a

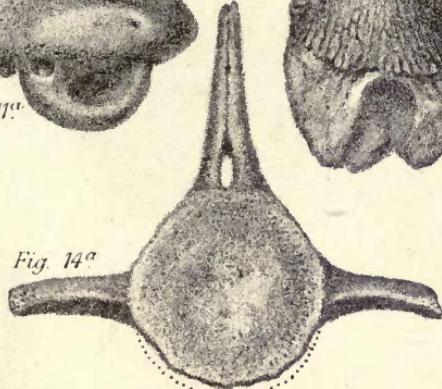


Fig. 14^b



Fig. 16^a



Fig. 16^b



Fig. 1.

PLATE IX.

1. DIOMEDEA sp. Right ulna, proximal half natural size. Coralline Crag, Orford. Pres. by Col. Alexander to M. P. G.
2. DIOMEDEA sp. Right tarso-metatarsus, natural size, after Lydekker. Sandy bed overlying Shelly Red Crag, Foxhall, Ipswich Mus.
3. DIOMEDEA sp. First phalangeal of fourth digit, natural size, found with last specimen. After Lydekker. Ipswich Mus.
- 4, a, b, c. BUBO IGNAVUS, *Forster*. Right tarso-metatarsus, natural size ; a, front, b, back, c, distal end. Forest-bed, East Runton. Savin Coll., Cromer.
- 5, a, b. URIA TROILE, *Linnæus*. Shaft of humerus, natural size ; a, side view, b, front view. Chillesford Crag, Aldeby. Crowfoot and Dowson Coll., Norwich Mus.
6. PHALACROCORAX CARBO, *Linnæus*. Upper part of coracoid, natural size. Forest-bed, West Runton. Barker Coll.
- 7, a, b. SPATULA CLYPEATA, *Linnæus*. Left coracoid, natural size ; a, inner, b, outer side. Forest-bed, West Runton. Barker Coll.
8. THYNNUS THYNNUS, *Linnæus*. Dorsal vertebra, half natural size. Forest-bed, East Runton. Savin Coll.
9. GALEUS CANIS, *Bonaparte*. Tooth, four times natural size. Pliocene, St. Erth, Cornwall. British Mus.
- 10, a, b. GALEUS, sp. Tooth, twice natural size, a, inner, b, outer side. Red Crag Nodule-bed, Little Bealings, near Woodbridge. Moor Coll., Great Bealings.
- 11, a, b, c. SQUATINA sp. Tooth, twice natural size, a, outer side, b, inner side, c, seen from above. Red Crag Nodule-bed, Little Bealings, near Woodbridge. Moor Coll., Great Bealings.
- 12, a, b. CETORHINUS MAXIMUS, *Linnæus*. Spine of clasper, half natural size ; a, outer, b, inner side. Red Crag Nodule-bed, near Woodbridge. M. P. G.
- 13, a, b. CARCHARODON MEGALODON, *Agassiz*. Tooth, half natural size ; a, outer side, b, side view. The margins show the remains of serrations. Red Crag Nodule-bed, Foxhall Hall, Ipswich. Cheadle Coll., M. P. G.
- 14, a, b. CARCHARODON RONDELETI, *M.* and *H.* Tooth, half natural size, with strongly serrated edges ; a, outer side, b, side view. Red Crag Nodule-bed, Boyton. M. P. G.
- 15, a, b. OXYRHINA HASTALIS, *Agassiz*. Tooth, half natural size ; a, outer side, b, side view. Red Crag Nodule-bed, Suffolk. M. P. G.
- 16, a, b. ODONTASPIS ELEGANS, *Agassiz*. Tooth, natural size ; a, outer side, b, side view. Red Crag Nodule-bed, Suffolk. M. P. G.
- 17, a, b. ODONTASPIS CONTORTIDENS, *Agassiz*. Tooth, natural size ; a, outer side, b, side view. Red Crag Nodule-bed, Boyton. M. P. G.
18. NOTIDANUS GIGAS, *Sismonda*. Tooth, natural size. Red Crag Nodule-bed, Boyton. M. P. G.
19. } RAJA CLAVATA, *Linnæus*. Two dermal defences, natural size. Red Crag Nodule-bed, Boyton. M. P. G.
20. } RAJA sp. Dermal defence, natural size ; a, from above, b, from below. Coralline Crag, near Gedgrave. M. P. G.
- 21, a, b.



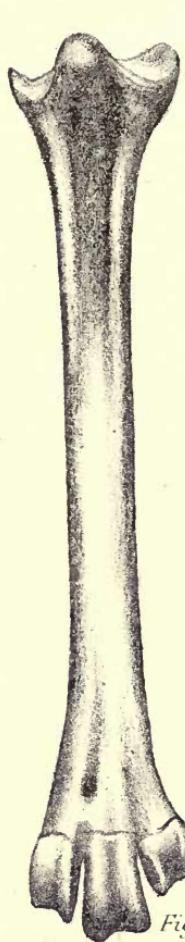


Fig. 2.

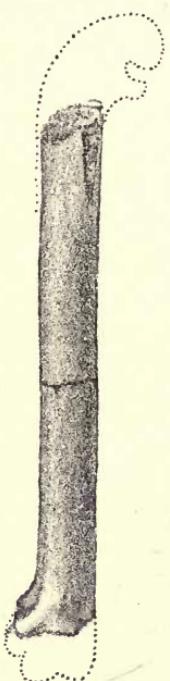


Fig. 5a.



Fig. 5.

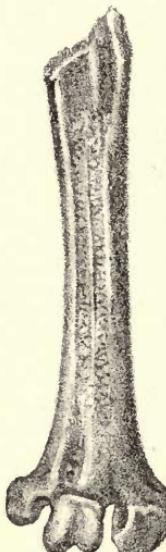


Fig. 4b

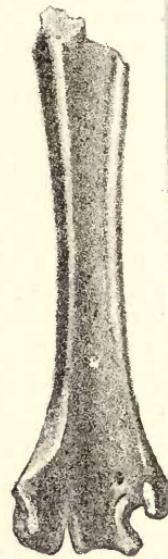


Fig. 4a

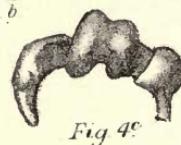


Fig. 4c



Fig. 6.



Fig. 19



Fig. 20



Fig. 3.

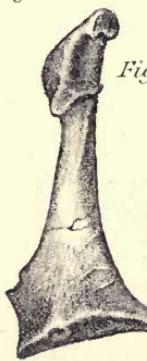


Fig. 7a

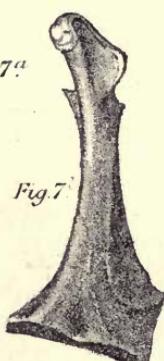


Fig. 7



Fig. 12a x 1/2



Fig. 12b x 1/2

Fig. 1.

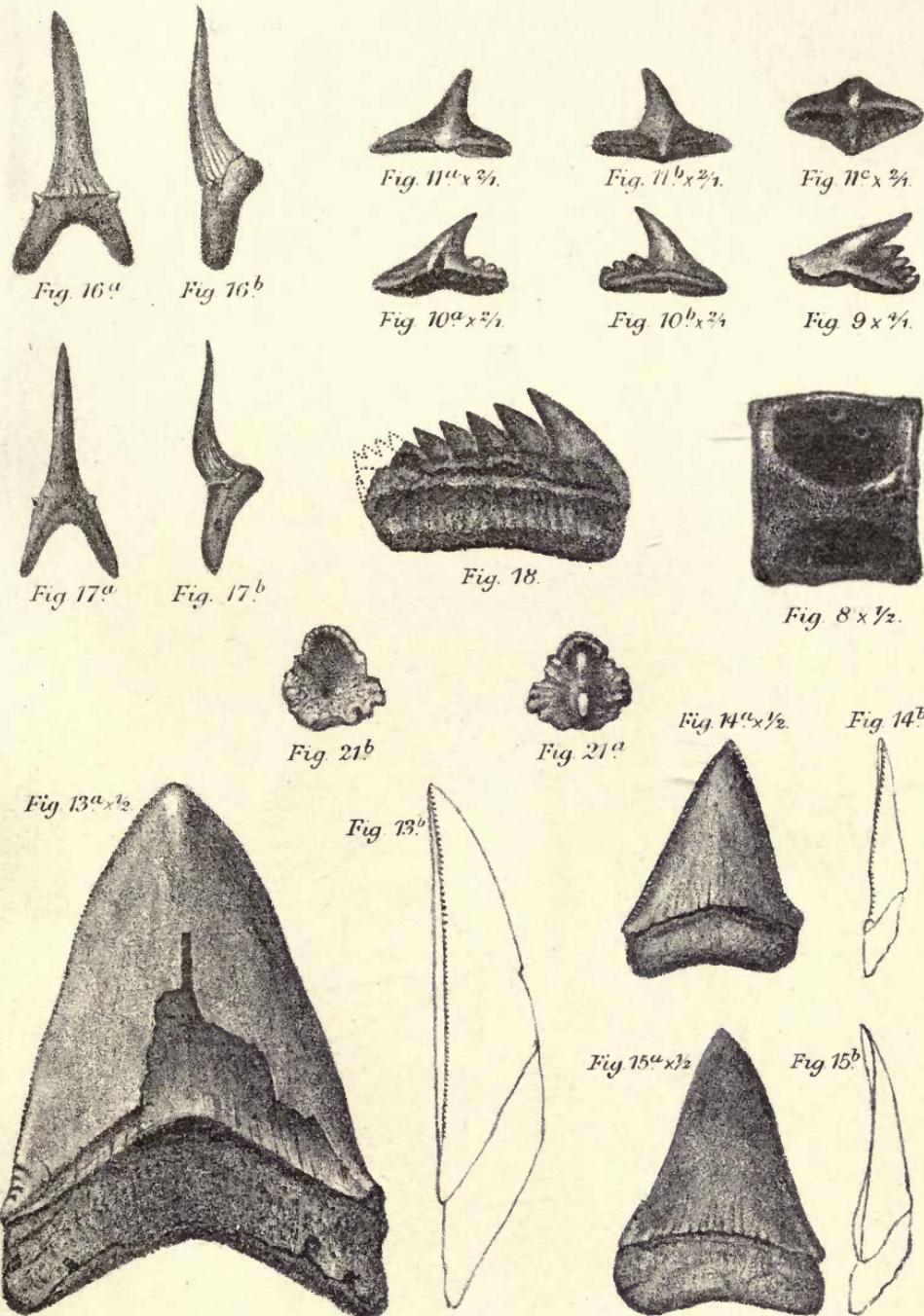




PLATE X.

Figures 1, 2, 3, and 17 natural size, 4-16, twice natural size.

1. CHYSOPHYS. Premaxilla? with three teeth. Red Crag Nodule-bed, Woodbridge. M. P. G.
2. CHYSOPHYS. Conical tooth. Red Crag Nodule-bed, Boyton. M. P. G.
3. CHYSOPHYS. Small rounded tooth. Red Crag Nodule-bed, Boyton. M. P. G.
- 4, a, b. ANARRHICHAS LUPUS, *Linnæus*. Tooth; *a*, side view, *b*, base. Coralline Crag, Gedgrave. M. P. G.
- 5, a, b. GADUS MORRHUA, *Linnæus*. Otolith, two views. Norwich Crag, Bramerton. Reeve Coll., Norwich.
- 6, a, b. GADUS PSEUDÆGLEFINUS, n. sp. Otolith, two views. Coralline Crag, Gedgrave. M. P. G.
7. GADUS PSEUDÆGLEFINUS, n. sp. Otolith of young specimen. Coralline Crag, Gedgrave. M. P. G.
- 8, a, b. GADUS LUSCUS, *Linnæus*. Otolith, two views. Red Crag, Boyton. M. P. G.
9. } GADUS MINUTUS, *Linnæus*. Three Otoliths. Coralline Crag, Sutton. M. P. G.
10. } GADUS MERLANGUS, *Linnæus*. Otolith, young. Pliocene. St. Erth, Cornwall. British Mus.
11. } GADUS VIRENS? *Linnæus*. Two Otoliths, young. Coralline Crag, Sutton. M. P. G.
- 15, a, b. GADUS POLLACHIUS, *Linnæus*. Portion of Otolith. Two views. Norwich Crag, Bramerton. Reeve Coll., Norwich.
16. GADUS ELEGANS, *Koken*. Otolith. Coralline Crag, Sutton. M. P. G.
17. ARIUS. Fragment of spine. Red Crag Nodule-bed, Foxhall. Moor Coll., Great Bealings.

Geological Survey of the United Kingdom.

Plate X.



Fig. 5^a $\times \frac{2}{3}$.



Fig. 5^b $\times \frac{2}{3}$.



Fig. 7 $\times \frac{2}{3}$.



Fig. 6^a $\times \frac{2}{3}$.

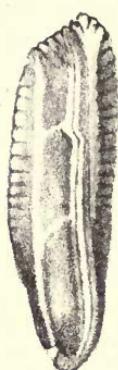


Fig. 6^b $\times \frac{2}{3}$.



Fig. 8^a $\times \frac{2}{3}$.



Fig. 8^b $\times \frac{2}{3}$.



Fig. 16 $\times \frac{2}{3}$.



Fig. 9 $\times \frac{2}{3}$.



Fig. 10 $\times \frac{2}{3}$.



Fig. 11 $\times \frac{2}{3}$.



Fig. 1.



Fig. 12^a $\times \frac{2}{3}$.



Fig. 12^b $\times \frac{2}{3}$.



Fig. 13 $\times \frac{2}{3}$.



Fig. 14 $\times \frac{2}{3}$.

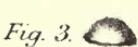


Fig. 4^a $\times \frac{2}{3}$.



Fig. 4^b $\times \frac{2}{3}$.



Fig. 15^a $\times \frac{2}{3}$.

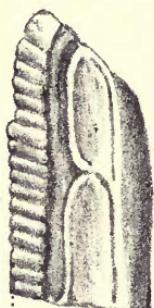


Fig. 15^b $\times \frac{2}{3}$.



Fig. 17.

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